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THE NEW YORK RAPID TRANSIT LAW was declared constitutional by the court of last resort on March 23. On the same day the plans for the road prepared by the Rapid Transit Commission were approved by the Common Council of New York city by a vote of 23 to 3. The only legal step now necessary preliminary to the construction of the road is the obtaining of the consents of the property owners adjacent to the line of the road. As the present route does not use any part of Broadway south of 42d St., it seems probable that the consents of a majority can be secured, and if this is done the appeal to the courts which was necessary under the plan formerly adopted on account of the opposition of the Broadway property owners, and which resulted in the defeat of the former plan will not be necessary.

THE CHICAGO & SOUTH SIDE RAPID TRANSIT OR "Alley" Elevated Railway will substitute electric power for the steam locomotives now in use, and plans and specifications are now being prepared for the necessary power plant and equipment by Sargent & Lundy, Electrical Engineers, of Chicago. It is estimated that the work will cost $1,500,000. This work will remove the last steam elevated railway in Chicago, the "Metropolitan," "Lake Street" and "Northwestern" roads being already operated by electricity.

TRACK ELEVATION IN CHICAGO is the important subject before the city council. The report of the committee on Sixteenth St. has been adopted, demanding that all the tracks at that dangerous point be depressed, with the exception of the St. Charles Air Line, which would be raised. To permit this change the tracks of the South Side Elevated Railway would also have to be raised higher at Sixteenth St., at an estimated cost of $35,000. But before doing this the officials of the elevated road demanded the right to build a connection of 166 ft. on Harrison St. with the Union Loop Line. This concession was granted by the council and the ordinance passed.

A STEEP GRADE ELECTRIC LINE is projected at St. Paul, Minn., in connection with a cable railway on Selby Ave. In view of the opposition to the line a committee consisting of Messrs. Tracy Lyon, E. H. McHenry, M. Am. Soc. C. E., and C. F. Loweth, M. Am. Soc. C. E., was appointed to report on the feasibility of operating electric cars on the grade. The report submitted by the committee was substantially as follows:

The commission has examined many plans and devices submitted for its consideration, and in addition, so far as the time would permit, has investigated the methods of operating on similar steep inclines already in operation. Of the many plans submitted, but one or two have been worked out in detail, and the majority are vague and impracticable. Very few new or valuable ideas were received, the plans in general being modifications of old and well-known devices.

The maximum grade on the Selby Ave. hill is 16% and approximately 500 ft. in length. At the intersection of Third St., at the foot of the steep grade, a sharp curve occurs, succeeded by a 9% grade 200 ft. in length. The commission believes that it is entirely safe and practicable to provide for the operation of electric cars on this hill, being led to this conclusion by the successful operation on even steeper and longer grades at other places, where various devices are used for solving similar problems, such as steam and electric hoists in mines; cables and counterweights as used in electric street railway practice in Easton, Pa.; Seattle, Wash.; Portland, Ore.; San Francisco, Cal.; Providence, R. I.; and Chattanooga, Tenn.; rack railways at Mt. Washington, Pike's Peak, Mt. Vesuvius, and in the Alps and South America; the 65% grade at Mt. Lowe, Wash., inclined planes at Cincinnati, Pittsburg and Allegheny; and hydraulic hoists and devices on inclined planes at Marseilles and in Switzerland. On many of these inclines the grade is 25% more.

The commission has not felt called upon to express an opinion regarding the relative commercial merits of the several systems nor to indorse any particular plan which has yet been submitted, understanding that only its opinion regarding the feasibility and safety of such operations is requested. It is probable that the adoption of some method involving the use of cable or rack-rail traction will ultimately furnish a satisfactory solution of the problem. The relative density of traffic and consequent number of cars employed in operation will determine the comparative economy of providing a local power installation for the hill operation only, as compared with the cost of specially equipping a greater or less number of cars. The adoption of the former plan would permit the general use of the incline by all the cars of the street railway system in and about the two cities.

THE READING RAILWAY SUBWAY IMPROVEMENT, in Philadelphia, is reported as moving rapidly and it will doubtless be completed within the two years yet remaining of the time allotted by law. The work of reconstructing the sewers has been finished, the excavation for the subway is far advanced, and the main retaining wall is being built.

A PUBLIC BOULEVARD is to be built at San Francisco, Cal., as a means of providing employment for the great number of men now out of work. It will form an extension of Seventh Ave., from H St. to Ingleside, a distance of 2½ miles, and it may be continued farther if the county supervisors grant the right of way. The road will be 100 ft. wide. It has been laid out by Mr. Schussler, civil engineer, for the Citizens' Relief Committee, and large quantities of tools and provisions have been donated. The men will receive $1 per day if the railway furnishes free transportation, or $1.10 per day if they have to purchase tickets.

THE HIGHWAYS OF MONTANA, by a bill lately passed by the State Legislature, are placed in the charge of the County Surveyor, and the old office of road supervisor, usually held by an inexperienced man, is abolished. The act defines the powers and duties of County Surveyors, and provides for their compensation. By this act each of these officers is required to keep the highways in his county clear of obstruction and in good repair and maintain bridges, to make all plans and specifications for new roads and bridges, to report to the County Commissioners on all work completed, and if the work is done according to the plans, specifications and contract, he is to draw his vouchers for the same before payment is made. The County Surveyor is chairman of all boards of viewers of roads, keeps the records of road surveys, and is the general superintendent of all roads. He may employ labor, teams, etc., and has power to contract for all work not exceeding $200 in cost; for larger amounts the approval of a majority of the Board of County Commissioners is required. The salary received varies with the class of county, from $750 to $2,000 per year. Viewers and all assistants of the County Surveyor may not receive more than $3 per day.

CONVICT LABOR IN ROAD BUILDING is being employed in Duval County, Florida, and in North Carolina. In the latter case 21½ cts. per day per head is said to cover the cost of food, clothes, medical attendance and guards, as compared with 28 cts. per day for maintaining the same prisoners in jail. The Duval Good Roads Association, of Florida, advocates the use of short-term convicts on such work, and makes the claim that they would in this manner pay back some of the money expended upon them, and they would also stand a better chance of being called back to an honest life, than if they were made to associate with more hardened criminals in a prison.

STATE AID FOR ROAD CONSTRUCTION is wanted in Wisconsin, and the board of directors of the Wisconsin League of Good Roads has asked the state legislature to take the first step toward the amendment of the constitution so as to admit of state aid for road building. The state constitution now provides that "the state shall never contract any debt for works of internal improvement or be a party in carrying on such works." The Good Roads League proposes to amend this by making an exception in the case of "wagon roads designed and to be used solely for free public travel."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of an express train on the Baltimore & Ohio R. R., near Oakland, Md., March 20. The train was east bound from St. Louis and Cincinnati, and was running at high speed. The engine, tender, baggage car and first passenger car were derailed and went down the bank. Two men were killed and 10 injured, some seriously.——A collision between the two sections of a parted freight train occurred March 23 on the viaduct carrying the Cleveland, Cincinnati, Chicago & St. Louis Ry. over the Ohio Southern R. R. at Buffalo Crossing, O. The structure gave way and 27 cars were smashed. It is reported that a number of tramps were riding in some of the cars that went down.

THE EXPLOSION OF A LOCOMOTIVE BOILER occurred on the Lake Shore & Michigan Southern Ry., at Chicago, on March 21, killing the engineman and fireman. The engine was hauling the eastbound Chicago and Boston express and was in the yards near South Park Ave. and 67th St. when the explosion occurred.

SERIOUS FLOODS exist in the Mississippi River valley owing to the numerous breaks in the levees caused by the high water. Great areas of land are under water and there has been much loss of life and property.

A TORNADO wrecked a school house at Arlington, Ga., March 22, causing the death of eight children, while 14 of the children and teachers were badly hurt.

A FIRE ON THE STEAMER "RIALTO," of the Wilson Line, on its voyage from Newcastle, England, to New York, caused the loss of the vessel at sea. There was a large quantity of chemicals among the cargo, and on March 3, during a storm, an explosion occurred in the hold, blowing off one of the hatches and setting fire to the cargo. While one of the engineers was standing over the hatch with the fire hose, a second explosion occurred, killing the engineer and blowing him overboard. The men were taken off by the Allen Line steamer "Carthaginian," on March 5, the "Rialto" being then in a sinking condition. The vessel was 310 ft. long, and of 1,799 tons burden.

THE LOSS OF THE STEAMER "Ville de St. Nazaire," on March 7, was one of the most terrible marine disasters of recent years. The vessel belonged to the French Line, plying between New York and West Indian ports. It sailed from New York on March 5, with 82 persons on board, including officers, crew and passengers, and encountered a very heavy storm off Cape Hatteras. The waves tore away the hatches and parts of the superstructure, filling the hold and putting out the fires. When it was seen that the vessel must sink, the boats were put out, but some of these were smashed in lowering, and only four boat loads got away. Three of these have not been heard from, and when the fourth was sighted by the schooner "Hilda" only four persons remained alive. Since writing the above a second boat is said to have been picked up with 16 persons in it.

TWO LARGE WESTINGHOUSE ENGINES BROKE down at the same time in the electric railway power house in Omaha, Neb., on March 17, leaving only one engine to run the plant. The account of the accident given in a local newspaper, which is not very clear, is as follows:

A crank pin in one of the engines broke, and in the other one of the pistons snapped. The belts flew off and both engines began racing, and the liberated cylinder head was churning up and down for a few seconds with the velocity of a cannon ball, until the end of the piston rod came in contact with the side of the enclosed box in which the cranks work. These heavy castings were instantly smashed to pieces and chunks of iron were sent flying all over the works. Fortunately, no one was hurt. The snow at the same time was seriously interfering with the movement of the trains and the accidents to the engines were due to the extra strain put upon the machinery to move the trains.

THE ELECTRICAL WORKS AND LABORATORY of Mr. Harry Barringer Cox, at St. Albans, Eng., which were totally destroyed by fire on Feb. 22, contained a valuable collection of electrical and other instruments, with the records of Mr. Cox's ten years' research into the problem of the cheap direct conversion of heat into electricity. Every one of his experiments had been photographed, and all these photographs were lost. We understand that Mr. Cox has been attempting to make a thermopile which would be commercially practicable as a generator of electric current.

DWELLING HOUSES ARE TO BE HEATED by electricity in Lewiston, Me., according to the "Journal," of that city, the power for generating the current being furnished by a waterfall at Turner, on the Androscoggin River. The projectors of the scheme say that they will be able to furnish power at less than $36 per HP. by the year, and that they can heat a 10-room house with 3 HP. the year round.

A CIVIL SERVICE EXAMINATION for a topographical draftsman will be held in New York on April 12. Mr. S. William Briscoe, New Criminal Court Building, is Secretary of the New York Civil Service Commission.

A CONTRACT FOR BRICK PAVING at 77 cts. per yard has just been awarded by the Board of Public Works of Columbus, O., to W. H. Luchtenberg. Repressed blocks will be used and about 4,000 yds. laid.

TRACK ELEVATION AT BROCKTON, MASS.; N. Y., N. H. & H. R. R.

The elevation of the tracks of the New York, New Haven & Hartford R. R., at Brockton, Mass., is now completed, and is an interesting example of work of this kind done on a somewhat elaborate scale to meet the demands of the municipal authorities. The total length of the change of grade is about 3 miles, of which 1.7 miles is elevated 15 ft. on an earth bank, between masonry retaining walls, while the balance of the line is depressed below the old grade, being in a wide shallow cut with few crossings. The maximum depth of depression below the old grade is 15 ft. There are 8 arches over highways, 2 plate girder bridges over highways, 7 highway bridges over the railway, 4 arches over streams, 3 arches in subways, and 1 footbridge, making a total of 25 bridges and arches, of which 15 are arches. By this new work 16 grade crossings have been abolished. Fig. 1 is a plan and profile of the line, showing the new and old grade lines. About five miles of street were built and paved, and a considerable amount of work done in relaying water pipe, building sewers, etc.

The arches are mainly of stone, with concrete backing, but there are two 30-ft. arches of brick, with six brick rings and stone facing. With this latter arrangement it is difficult to get the bricks to exactly fit the joints of the stones in the spaces between the stone headers and stretchers. In one arch the bricks are laid in courses of headers and stretchers, so as to fit the stones, while in the other arch cut bricks or shims are used to bring the joint up to the required line. The former is the better construction, but rather spoils the appearance of the arch. The masonry is of granite, in rock-faced blocks of large size, the stretchers being 8 ft. long, and a peculiar feature is that the arches are carried down to the sidewalk level, as shown in Fig. 2. This saves some masonry, and gives a good appearance. The abutment walls at ends of arches are carried up vertically at the inner edge of the sidewalk (as shown by the dotted lines), so as to prevent people from walking so close as to strike their hats or heads against the under side of the arch. There is a curb joining these walls along the inner edge of the sidewalk, and the space from the curb to the arch is paved with asphalt.

Concrete was largely used for foundations and backings, since its cost was but $5 per cu. yd., as compared with $24 for arch stone masonry. Masonry work was carried on throughout the winter of 1894-95, and no defects have been found to result therefrom. American Portland cement was used, and the water, sand and stone were heated. Salt water was used to some extent, but was not liked, as it made the joints sloppy. The filling-in between the masonry retaining walls was done by trains of small dump cars, the haul being about three miles. The masonry is of very handsome appearance, and a good example is shown by the 50-ft. arch, at Center St., Fig. 3.

In carrying out the work, temporary tracks were laid alongside the old tracks, outside the line of the new work, so that the work was done entirely independent of the traffic. The arch centers were so made as to have a strip of lagging at each joint of the stone. The centers of the joints were marked with tacks, and stones laid to these tacks, with ½-in. joints. Thus there was no creeping, and all joints and stones were alike, no special keystones being used. Mixing boards were laid on the crown of the arch, and the concrete thrown directly into place for the backing. In regard to the use of masonry arches at a time when metal bridge work is so cheap, it is explained that such masonry is not so enormously expensive as is sometimes thought, and is likely to be really more economical than the metal if the cost of the masonry bridge complete is compared with that for a modern heavy steel bridge with solid floor and masonry abutments, and taking into account also the cost for maintenance, painting, etc., of the steel structure. In this particular case the cost is somewhat increased by the amount of headway demanded by the city. This entails an extra height to be climbed by every passenger, and the city authorities have immediately reduced the headway by 10 or 15 ins. by permitting the placing of supports for electric wires and lamps at the crown of the arch.

The line has four tracks through Brockton, and the width of roadway is 50 ft., the tracks being 13 ft. c. to c. The tracks are laid with 100-lb. rails, and in all 30 miles of permanent track have been laid, including the yard. There are freight tracks parallel with the main tracks, on which the through freight trains leave the cars for the city.

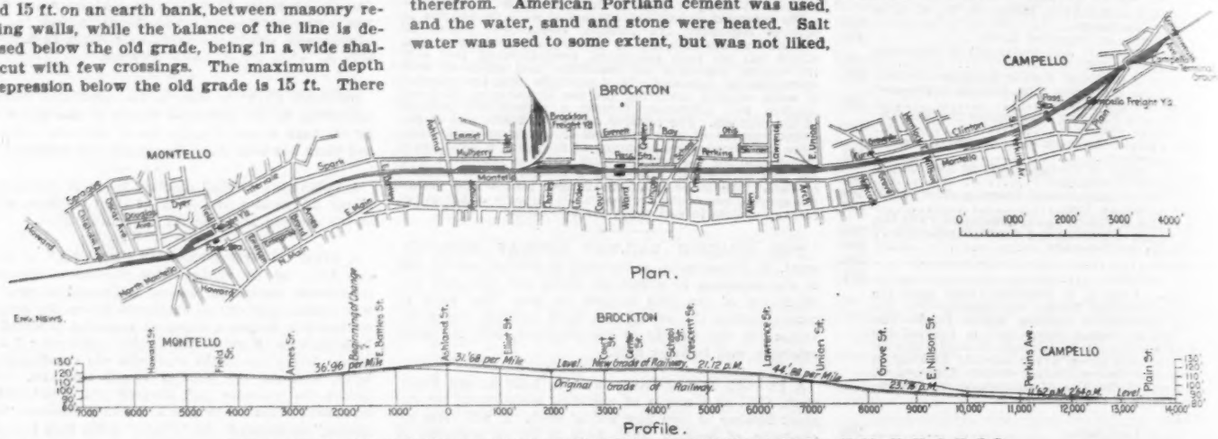

FIG. 1.—PLAN AND PROFILE OF TRACK ELEVATION AT BROCKTON, MASS.; N. Y., N. H. & H. R.R.

Switch engines then take the cars down an inclined track on a curve of 8° to the main freight yard, which is on the street level. This low level yard has accommodation for about 1,000 cars. The plan of this yard is shown in Fig. 1, by which it will be seen that the yard tracks are practically at right angles to the main tracks. Cars from the main tracks are taken down the incline and onto the straight stub tracks, from which they are backed onto the yard tracks. The yard has an area of 42.67 acres, and there are two freight sheds, 25×300 ft. and 25×547 ft.

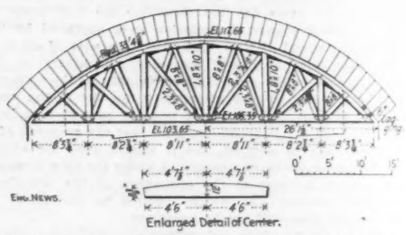

Fig. 2.—Centering for Elliot St. Bridge, Brockton, Mass.; N. Y., N. H. & H. R.R.

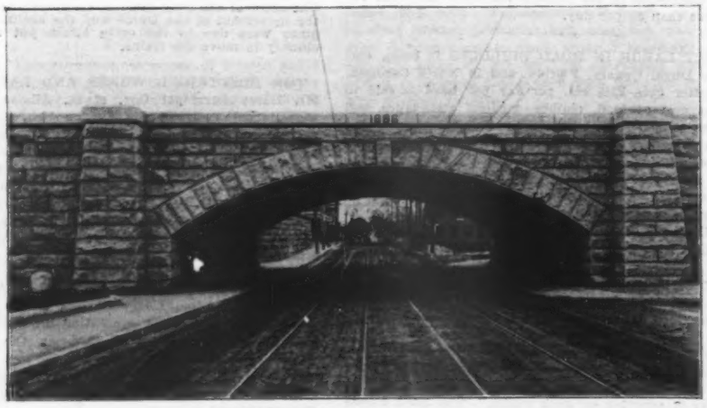

FIG. 3.—CENTER ST. ARCH, BROCKTON, MASS.; N. Y., N. H. & H. R. R.

The Salisbury River is spanned by two 16-ft. span arches, 160 ft. long, with curved training walls to form the channel. Mr. Joseph Ross, of Boston, Mass., was the contractor for this and some of the other arches.

The main station at Brockton is a double station, with a building on each side of the track for ticket offices, waiting rooms, etc. The two middle tracks (for express trains) will be fenced off, access between the two sides of the station being provided by a subway having glazed brick lining, and Guastavino arches at the ends. The buildings are of Milford granite, with brown stone trimmings and slate roofs. The interior has glazed faience tiling for the lower part of the walls, and hardwood finish above. The floors are of thrown mosaic, and the toilet rooms are finished in marble. The platforms are of granolithic paving, and have shelter roofs, supported by posts of varnished Georgia pine. A view of the station is given in Fig. 4. The station at the suburb of Campello is of similar design, but smaller. The subway of this station is in wet ground, and its construction, in order to make it waterproof, is shown in Fig. 5. Both stations are of attractive design and finish. The architect was Mr. Bradford L. Gilbert, of New York.

The total cost of the work will be about $2,000,000, including stations and yards at Montello and Campello, freight yards, street and sewer work,

ete. Of this the state will pay 35%, based on the quantity returns submitted by the company, and will collect 10% of this from the city during a period of ten years.

The work was done under the direction of Mr. J. W. Rollins, Jr., Engineer of Construction, subject to the general supervision of Mr. F. S. Curtis, M. Am. Soc. C. E., Chief Engineer. The general contractors were Dwight & Daly, of New York, and Holbrook, Cabot & Daly, of Quincy, Mass.

FIG. 4.—VIEW OF NEW STATION AT BROCKTON, MASS.; N. Y., N. H. & H. R. R.

The accompanying plans and views are taken from a very handsome collection prepared by Mr. Rollins and the contractors, for a copy of which we are indebted to Mr. F. Holbrook, of Quincy, Mass. Mr. Rollins is now Assistant Engineer of Construction at Forest Hills, Mass., in charge of the track elevation work described and illustrated in our issue of Jan. 14.

RECENT LEGISLATION ON IMPROVED ROADS.

By. J. L. Van Ornum.*

The growing interest in "good roads" among a large part of the people results from a realization of their necessity and economic value. Just at present is a most fitting time for their brief consideration, as a number of state legislatures are considering bills for their improvement.

The great necessity in the development of improved highways is adequate laws under which they may be built. Not only must there be full legal authority for such expensive construction, but also the expense must be carefully adjusted among all the interests benefited, and their construction must be fostered by providing means for wise administration, adequate supervision and scientific construction.

Examining the general road laws of the states and territories, it is found that in them all the maintenance and repairs of roads and bridges, except when the expense is unusual, is borne by road districts (which sometimes correspond in extent with townships), under the direction of a road overseer. The general control of roads and bridges, however, including the authority to open and discontinue roads, assess damages for their opening, establish road districts, appoint road overseers, control directly the larger expenditures, and all matters relating to general supervision is vested, by more than three-fourths of the commonwealths, in the executive board of each county, usually called the Board of County Commissioners or County Court. In New Hampshire, Vermont, Rhode Island, Connecticut, New York, New Jersey, Illinois, Michigan, Wisconsin, North Dakota and South Dakota the towns (townships) have general control, which may be exercised by the county board only in special cases. It is not uncommon for a state to require the board having supervision to submit the question of an unusual expenditure to a vote of the people, but this detail is wholly dependent upon the will of the state as expressed by its legislature. Bridges of small cost are constructed by the road districts just as the roads are worked, but larger ones are generally built by the townships or counties from the town or county funds.

These general road laws are well adapted for the construction of ordinary highways, but they are entirely inadequate when necessity requires an elaborate and expensive construction. The earliest method of providing for this necessity was that of chartering companies for the building of toll roads or turnpikes. This method became very general, and still exists in many states. It possesses the advantage of confining the payment for the improvement to those profiting by it, and proportioning such payment to the amount of the using, but the system is not now viewed favorably. It is not considered good policy to give private corporations so much control of public highways, and where charters have not lapsed

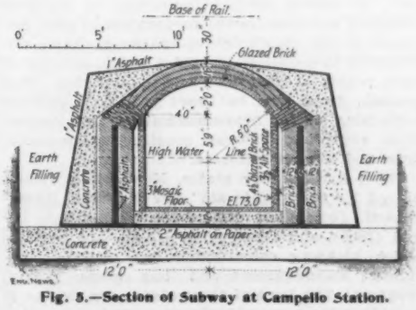

Fig. 5.—Section of Subway at Campello Station.

or the ownership of such roads has not been acquired by the county or township officers, the people are becoming restive. Toll roads may still have a local advantage at times, and a place in the statutes, but as a general solution of the problem they are unsuitable.

State roads or turnpikes have been at times extensively built at the expense of the state. Often their use have been subject to the payment of toll with which to reimburse the state for at least a portion of the expense. Before the building of railways the Eastern states did considerable work of this kind, and later the new states have constructed them to develop their territory; and even now some of the new Northwestern states devote a portion of the state funds to this purpose. In general, however, railroad construction having made communication easy, the feeling that public ways should be entirely free, and the principle that the whole commonwealth should not bear the expense of a local improvement, have put an end to the growth of this system.

Most of the states have passed special laws for improved roads at different times, and some good construction has resulted; yet work under such special authority is likely to be irregular, uncertain and spasmodic, and is at best only local. Consequently the general discussion must exclude such.

About half of the states have general laws, more or less extensive, providing for improved construction. Those of Indiana, Kentucky, Kansas, Michigan, Nebraska, Texas, Vermont, Virginia and West Virginia were many of them passed many years ago, and as a rule merely give the county board power, to a certain limit, to construct such roads at the county expense, and under their usual road officers; in Nebraska the adjoining property pays one-third the expense; engineering supervision is unprovided for, except in the case of Indiana, Kentucky and Virginia. A distinctive feature in these state laws is the lack of an adequate provision for raising funds to meet the unusual expense involved.

More extensive laws exist in Illinois, Minnesota, New York, Ohio, Oregon, Pennsylvania, Missouri, Washington and Wisconsin. Here again the county board controls, but the provision for scientific supervision is much superior to that in the first group, as each county is authorized to secure the services of a competent civil engineer to survey and make plans and estimates for the work and usually to supervise construction. The expense of construction is borne by the county again in New York and Pennsylvania; by the township in Illinois; it may be placed on the county or on the property near in Minnesota and Washington; in Wisconsin the whole cost is assessed upon property abutting according to its frontage on the improvement, a majority of the property owners having petitioned; Ohio provides for "one mile assessment pikes," constructed after petitioned by a majority of property owners within one mile of the proposed improvement, on whom the cost is assessed, and for "two mile assessment pikes," where property within two miles pays half the expense and the county half; Oregon assesses the cost on lands within three miles, after petition of a majority of such landowners, but the county has the privilege of paying half; Missouri requires a petition from two-thirds the property holders living near, and assesses the cost upon such lands, or the property and the county may divide the expense equally between them; or on a favorable two-thirds vote the county may pay the expense up to five per cent. of its assessed valuation, or the township may pay by special taxation within the same limit. Counties are authorized to issue bonds for these works, except in Pennsylvania, where a tax of not over two mills on the dollar is provided for, and in Illinois, where the tax is on the township and is not to exceed one per cent. The construction is made by contract.

Considerable correspondence with engineers and state officials has discovered only four, among the states above mentioned, where actual construction has been fostered to any extent by the above laws. In Illinois there are a very few centers of interest where some work has been done, as in Monmouth township, Warren Co., which has constructed five miles of macadam and more than half a mile of brick pavement, seven feet wide, flanked by broken stone.

Ohio has had the "one mile and two mile assessment pike" laws for fifteen or twenty years, and a considerable amount of construction has developed under them. The mileage cannot be learned, but that the state has many excellent roads so built is certain. The road laws are much in favor of this commonwealth and their provisions are taken advantage of quite frequently by its citizens.

In the state of New York the real activity which has taken place under the laws (passed about five

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years ago) centers in Queens County. Lying just outside of Brooklyn, its roads are much used both by those driving and wheeling from the city and by the Queen's County farmers and market gardeners. There is a total of 104 miles in the system as now planned, 24 miles of which is under construction. Provision is made to secure good roads for pleasure driving and at the same time substantial ones for the 3,000 farmers' wagons using the public highways, and whose loads weigh four or five tons. The telford construction has been discarded and macadamized roads only are now built. Another special feature of these roads is the method of maintenance. The mileage is divided into five sections, each in charge of a foreman whose men are at work on resurfacing and repairing throughout the entire year. The success of these roads is ascribed to the method of construction and the system of continual maintenance. Mr. John J. McLaughlin, M. Am. Soc. C. E., who has kindly furnished most of the above facts, states that the present cost of construction is only about half the amount expended per mile before the adoption of the New York County Road system.

The Pennsylvania law was passed only two years ago, and as yet little practical work has been done. Delaware, Montgomery and Bucks Counties seem to be the centers of interest in the question as far as it has been developed.

Excepting five states, there is in this country actually no general interest in highway improvement, such as the importance of the subject demands. Comparison of the situation in our states with that under the European governments (where good roads of surprising quality and efficiency are the rule) there is seen to be a startling inadequacy in our condition. While something of this difference may be due to a much larger settlement and greater density of population in Europe, it is probable that such is not the principal reason, for much the same contrast occurs in comparison with our older and more populous commonwealths.

The chief cause of our extravagant backwardness lies in the general failure to provide state aid and control. It is under these conditions that the road systems of Europe have been developed, and the same is true of all our own states, with the possible exception of Ohio. Under the systems thus far mentioned the cost is, as a rule, provided for as an assessment upon property near, and is a very considerable expense to the agricultural classes. While improved roads would actually result in a real economy to these, the fact remains that this is not generally realized by these interests, but it is rather deemed a hardship and imposition when such a procedure is suggested. Illustrations of this mistaken view are not rare. Not long ago the president of a railway offered to township officers in Illinois, along the line of his railway, all the gravel they would use on their highways, tributary to his line, at the mere actual cost of hauling. Although this was an unusually good material of its kind, and there was absolutely no expense for the gravel itself, such was the indifference of those townships that no advantage was taken of the offer. A prominent engineer writes from Wisconsin:

> I am told the law is a dead letter except in some rare localities, and I haven't found any of those "rare" places myself. Every farmer I have talked with gets hot and says it is all on acount of "them bicycle fellows." We have a big agricultural community to educate. * * * The farmer is almost as big a hater of civil engineers as of bicycle fellows, and where I have made two speeches on good roads I killed myself professionally, for this generation at least.

With such a mistaken belief on the part of those most interested, and on whom the initiative and burden of such work generally falls, the remedy lies only in state aid. This course has been freely adopted under similar exigencies all through our history, as being truly for the promotion of the general welfare. The numerous works of internal improvement, building of public institutions, and the public school systems are examples in point. There exists a mistaken opposition to the growth of this great economy. It is for the state to demonstrate its real advantage by actively encouraging construction, and so disarming objection.

The courts of one state, Pennsylvania, have pronounced unconstitutional a law assessing the cost of construction on adjacent farm lands. The decision turned upon the fact that such an improvement is for the benefit of the public in general, and not only for that of the property near. Since this decision the Pennsylvania roads are built at the expense of the county, as are those of New York. Examples where the state bears the greater part of the expense are furnished by Massachusetts and Rhode Island; while Ohio assesses all the cost on adjoining lands.

It is submitted that the true solution is to divide the cost between the state, the county and the adjoining lands, because this course is most just. The expense should lie where the benefits are found, and should be in proportion to them. While the lands near receive a peculiar benefit from an improved road, the county as a whole is also distinctly benefited because of the use of such roads more or less by all its people; and by reason of the increased prosperity to the whole region that business activity and facilities bring, the state also is distinctly benefited because its interests are served by the greater resulting prosperity of its people, bringing honor and revenue to it as reward for its wise interest.

The proportion that each should bear can easily be varied according to the especial circumstances and exigencies in each case. By varying the percentage so that the cost shall not fall unduly upon the lands, the county or the state, the expense will be distributed according to the benefits, and none feel aggrieved. An incidental but important benefit to the county will result from its securing a voice in the roads to be improved, and so securing construction on its most important thoroughfares. A real advantage and economy results to all interested because of state aid and control, which gives uniformity of construction, work under a general plan, and the advantage of the highest degree of executive ability and technical skill.

The law of California furnishes an excellent model to states desiring more adequate statutes. This law, which was passed in 1895, provides for a state "Bureau of Highways" of three persons, receiving a salary of $3,000 per annum each and expenses, appointed by the Governor for two years, and selected with "particular reference to their qualifications" for such duties. They are to collect general road statistics from each county; to make inquiry concerning pertinent geological and topographical features of different portions of the state; to critically examine the California state road laws and inquire into laws and methods of improvements of other states for the purpose of judging what provisions can be best adopted to California and best serve its interests; to make general plans of improved roads, bridges, culverts, etc.; to furnish advice and information free, to county officers inquiring, on pertinent subjects; to supervise the preparation of road materials at the state's prison and its equitable distribution to counties; to hold a public meeting in each county at least once a year; and they "shall publish, from time to time * * * * bulletins containing useful recommendations and instructions regarding highway construction, maintenance and kindred subjects."

The following four states, New Jersey (which passed its first "state aid" law in 1891), Massachusetts (whose law dates from 1893), Rhode Island (1895), and Connecticut (1895), are those in which highway construction has received substantial enouragement and has made general progress. The laws of these states are similar in providing for a state highway commission which gives information and advice, and has general supervision and control of construction; in requiring the county board (or town officers in Rhode Island and Connecticut) to take the initiative in filing a petition to the commission, with a plan and profile of the proposed work; in requiring the highway commission to pass upon the application (and in Rhode Island the petition must be also acted upon by the state legislature); and on favorable action the construction of the road under the plans and specifications approved by the commission and under their control (except in New Jersey, where the county board lets the contract, but the highway commission inspects the work). The principal restriction on this control in Massachusetts is the requirement that the contract for construction of portions of the road shall be let to the town or city in which such portion shall lie, if it so elects. Repairs are made in New Jersey by the county—in Massachusetts by the state—and in Rhode Island and Connecticut by the townships. All the commissions, except that of Rhode Island, have issued valuable annual reports.

Provisions involving a considerable difference in the practice of these four states follow: Rhode Island calls roads that have received specific appropriations from the legislature "State highways"; without such legislative action the state commissioner may macadamize sample half-mile sections of roads on proper application from the towns, in which case the township is to bear one-fourth the expense and the state three-fourths. The State Commissioner of Highways is required to be a competent civil engineer, is elected by the state assembly for five years and receives $3,000 per year and expenses. Connecticut has three members in its "Board of Highway Commissioners," who are appointed by the governor and confirmed by the Senate for six years; at least one of them must be an experienced civil engineer, and they each receive $8 per day and expenses while actually employed. Special provisions of the Massachusetts law are the requirement that at least one public meeting each year shall be held in each county of the state by the commission; the appointment by the governor with the consent of the council of this "Massachusetts Highway Commission," consisting of "three competent persons" for terms of three years at a salary of $2,000 and traveling expenses; the making of these improved roads "State highways"; and the fact that the construction is confined between the inner (road) side of the sidewalk lines. Distinctive features of the New Jersey law are the appointment of the State Commissioner of Public Roads for three years at a salary of $5 per day and expenses; and the provision for a rebate of taxes by the township authorities up to $1 per wheel for wagons equipped with tires over 4 ins. in width.

The distribution of the cost of these roads in Rhode Island is subject to the provision of the state legislature in each case. On account of the small size of the state this provision, partaking of the character of special enactment for each project, is not as objectionable as it would usually be. Connecticut places one-third the cost on the state, one-third on the county and one-third on the town. In Massachusetts the state bears three-fourths of the expense and one-fourth is paid by the county. The New Jersey law provides for the state paying one-third the cost, the county seventeen-thirtieths, and the lands bordering the road one-tenth. Significant modifications in the development of these laws are the fact that in Massachusetts the state at first bore all the expense, but in 1894 put one-fourth of it on the county. In New Jersey the present effective law of general application and advantage is the successor of a "Township roads act," passed in 1888, placing on them the cost and control of construction of whose provisions Neptune Township, Monmouth County, and Chester Township, Burlington County, availed themselves soon after its passage by expending a total of about $70,000); and a "County bonding law," passed in 1889 (providing for placing two-thirds the cost on the county and one-third on the township), and applied by Union, Passaic and Morris counties on a total construction of over 200 miles of macadamized roads at an expense of over $1,300,000. It, therefore, seems that the tendency of legislation, as well as the considerations of fairness and justice, incline toward the distribution of the cost between the state, the county and the lands contiguous.

The appropriations by the state of Massachusetts have been $300,000 in 1894, $400,000 in 1895, and $600,000 in 1896. In Connecticut the limit of state aid is $75,000 per year, not more than $3,000 of which is to be expended in one township per year; the township's share cannot exceed ½% of the assessment of the last preceding year; the state's share of expenses to date has been about $177,000. In New Jersey the state's share in one year must not exceed $100,000, and

the expense to the county must not exceed ¼% of the ratables of the county for the preceding year if raised by tax, but otherwise bonds may be issued; if for any reason improvements cannot be otherwise secured when desired, property-owners may petition for the total expense to be put upon them and construction will be thus secured. The total appropriation of New Jersey thus far has been $467,000. Although these expenses seem great, a suggestion of the real economic value of the improvement is furnished by the statement that in certain localities where such roads have been constructed the average value of farms has been doubled as a consequence; and although Union County, N. J., spent $500,000 in road construction its real estate increased so much in value that the tax rate was lower than before its assumption of the debt.

The mileage of state roads in Massachusetts is about 126, of which 100 miles have been actually built; the city and county appropriations aggregate about $1,500,000. New Jersey has a total of 300 miles constructed and contracted for, the total fund thus far raised by the state, counties and land owners amounting to about $1,400,000. In Connecticut there have been constructed 75 miles of improved roads at a total expense of about $500,000.

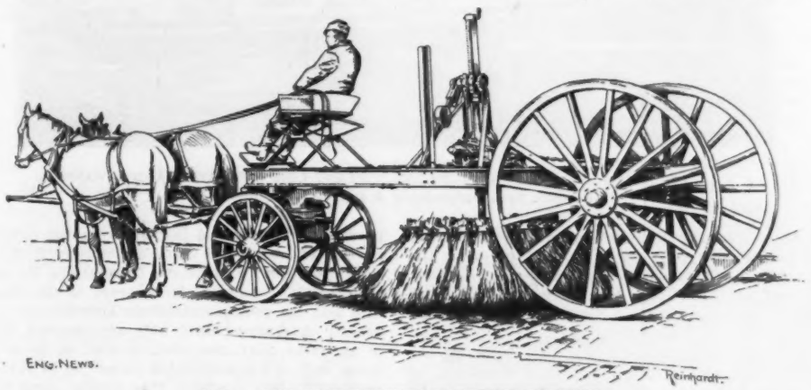


FIG. 1.—PERSPECTIVE VIEW OF GUTTER SWEEPER.
Designed by Henry Mueller, Jr.; Manufactured by the Street Sweeping & Loading Machine Co., St. Louis, Mo.

THE MUELLER "PICK-UP" AND GUTTER STREET SWEEPING MACHINES.

We illustrate herewith a rotary gutter sweeper and also a "pick-up" or "piler" sweeper, for collecting and piling street sweepings from the windrow left by the ordinary side sweepers, which have been employed in the city of St. Louis for some years and are now manufactured for general sale by the Street Sweeping & Loading Machine Co., of that city. These machines are the design of Mr. Henry Mueller, Jr., and were developed to meet the requirements of his work as a contractor for street cleaning. Besides nearly six years continued use in St. Louis, both the gutter and the "pick-up" machines have been used in a number of Western cities, notably in Chicago, Indianapolis and Memphis.

Fig. 1 shows the gutter sweeper, which, as its name signifies, is employed to clear the gutters close to the curb where the ordinary side sweeper cannot be employed. This machine is drawn by two light mules or a single heavy horse, and clears a space somewhat over 4 ft. wide, throwing the dirt from the curb toward the center of the street. The engraving shows the construction and operation of the sweeper quite clearly. It will be noted that the broom rotates in the direction of the joints of the pavement. Birch brooms are used, with 18 bunches to the broom, and one broom is said to last from 13 to 14 nights under ordinary use.

The "pick-up" sweeper is shown in diagram by Fig. 2. Referring to this illustration it will be seen that by means of the foot lever, A, a clutch is thrown into action which causes the drum, B, located about midway on the shaft, to revolve in the direction of the arrow. From this point the train of mechanism operating the brush and dumping hopper can be easily followed in the drawing, in which the dotted lines show the position of the parts in the act of dumping. The use of the hand lever at the rear is obviously to enable the broom to be lifted clear of the street when not in operation. This machine will pick up the sweepings from a windrow not over 4½ ft. wide. In ordinary practice in the city of St. Louis, the hopper has to be dumped once in every two blocks. This dumping is done by the driver, who is the only man employed in operating the machine. Regarding the operation and advantages of these sweepers, Mr. Mueller, the designer, writes as follows:

> By using our gutter sweeper, two ordinary side sweepers and the pick-up sweeper, the entire width of the street, including the gutters, is cleaned and the dirt left in piles ready for loading. When we did the work in the old way of sweeping to the gutter and piling by hand, we used eight side sweepers, 38 men and 19 wagons. Now to do the same amount of work we use four side sweepers, two pick-up sweepers, two gutter sweepers and 13 wagons. The piles being left further apart and being much larger than by the ordinary way, the wagon drivers have to make fewer stops, and consequently handle more loads each night.

THE ELEVATION OF THE OUTER RAIL OF RAILWAY CURVES.

In the last issue of "The Polytechnic," Prof. Wm. G. Raymond, of the Rensselaer Polytechnic Institute, Troy, N. Y., discusses the proper amount of cant to give railway track on curves. As this paper is modified from a forthcoming text-book on "The Elements of Railroad Engineering," we give only the following abstract: The common rate of cant is one-half inch per degree of curve, as deduced from the generally accepted formula,

$$E = K\frac{V^2}{R}. \qquad (1)$$

where E is the difference in elevation of the two rails; V, the velocity of the train; and R, the radius of the curve. The velocity corresponding to one-half inch elevation per degree of curve is about 26⅔ miles per hour.

This equation, Prof. Raymond says, is theoretically incorrect, though it gives a very close approximation to the true cant. But the one-half inch rule, applied regardless of the speed of trains, is far from being correct. The reasons for canting the track on curves are apparent; on a flat curve the train is forced to take the curved path by the pressure of the outer rail on the flanges of the outer wheels. This deviating force tends to produce an overturning moment equal to the product of the force by the vertical distance from the rail to the center of gravity of the car; and the greater the speed, the greater the rail pressure on the flange, and the greater the overturning moment. The canting of the track provides a means of counteracting this deviating force. Prof. Raymond then gives the derivation

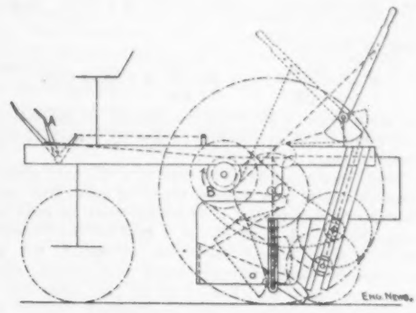


Fig. 2.—Diagram Showing Operation of Pick-Up Sweeper.

of an approximate formula for "the superelevation of the outer rail;" which, for a standard gage of 4 ft. 8½ ins., or G = 4.9 ft., is

$$E = \frac{.8277\ V^2}{R}. \qquad (2)$$

From this formula it appears that the cant should be proportional to the square of the velocity and inversely proportional to the radius of curvature, or directly as the degree of curve. Neither of these relations is quite true, though the maximum error of the formula will rarely reach one-half inch, even on sharp curves with high speeds. A more rigid, but more complex formula, for standard gage and velocity in miles per hour, is:

$$E = \frac{4.9}{\sqrt{1 + 223.64\frac{R^2}{V^4}}}. \qquad (3)$$

This latter formula is tabulated in inches in the table given herewith. With no table at hand equation (2) is most readily remembered and solved, and is sufficiently precise. The one-half inch per degree rule should never be used.

Prof. Raymond tabulates the errors resulting from the use of the rule objected to and gives some practical illustrations of the application of both this rule and the formula (2). In practice almost all trackmen use formula (2), varying the constant coefficient a little, according to the gage. The chief difference in practice is as to the assumed speed; some engineers employing the fastest passenger speed over the line; others the speed of the majority of passenger trains, and others still the average speed of passenger and freight trains. With a limit of 9 ins. for the cant, the precise maximum speed, producing no

Degree.	Speed in Miles per Hour.											Degree.
	10	15	20	25	30	35	40	45	50	55	60	
1	1/16	1/4	1/4	7/16	1/2	11/16	1 1/16	1 1/4	1 1/16	2 1/16	2 1/4	1
2	1/4	7/16	7/16	1/2	1 1/4	1 11/16	2 1/16	2 1/4	3 1/16	4 1/4	4 11/16	2
3	7/16	1/16	11/16	1 7/16	1 1/4	2 1/4	3 1/16	4 1/4	5 1/4	6 3/16	7 1/4	3
4	1/4	1/2	1 1/16	1 11/16	2 1/4	3 1/4	4 1/4	5 7/16	6 11/16	8 1/4	9 1/4	4
5	1/2	1/4	1 1/4	2 1/4	3 1/16	4 1/16	5 1/16	6 1/4	8 1/4	10 1/4	12 1/16	5
6	7/16	11/16	1 1/2	2 1/16	3 11/16	5.0	6 3/16	8 1/4	10 1/4	13 3/8		6
7	1/4	1 1/16	1 11/16	3.0	4 1/16	5 11/16	7 1/8	9 1/16	11 1/4			7
8	7/16	1 1/4	2 1/16	3 1/4	4 1/4	6 3/16	8 1/16	10 1/4				8
9	1/2	1 1/4	2 1/4	3 11/16	5 1/4	7 1/4	9 1/4	12 3/16				9
10	11/16	1 7/16	2 1/4	4 1/4	6 1/4	8 1/16	10 1/4					10
11	1/2	1 11/16	3.0	4 11/16	6 1/4	9 1/4	11 1/16					11
12	11/16	1 1/4	3 1/16	5 1/4	7 1/16	9 11/16	12 1/16					12
14	11/16	2 1/16	3 11/16	5 11/16	8 1/16	11 1/4						14
16	1 1/16	2 1/4	4 1/4	6 11/16	9 1/16	13 1/16						16
18	1 1/4	2 1/4	4 11/16	7 1/4	10 1/4							18
20	1 1/4	3 1/16	5 7/16	8 1/4	12.0							20
24	1 1/2	3 11/16	6 1/4	10 7/16								24
30	2.0	4 1/16	8 1/16	12 7/16								30
40	2 11/16	6.0	10 7/16									40

ELEVATIONS IN INCHES TO BE GIVEN TO THE OUTER RAIL ON CURVES FROM 1° TO 40° FOR SPEEDS OF 10 TO 60 MILES PER HOUR.

unpleasant sensation on any of the various curves, may be obtained from either of the formulas (2) or (3) by substituting 0.75 for E and solving for V. Assuming for equation (2) $R = \frac{5730}{D}$ these values become

$$V = \frac{114.8}{\sqrt{D}}, \text{ or } V = \sqrt{\frac{0.75}{4.9}\,(1 + 223.64\,R^2)}.$$

A table is given showing the speeds, to the nearest mile, that correspond to the 6, 9 and 12-in. limit of cant.

Prof. Raymond believes that it is the best practice on single and double track to cant the rail for the fastest trains, considering that on curves requiring more than about 9 ins. of cant there will be some slight reduction of speed. On a four-track road, running extra fast trains, the cant limit may well extend to 12 ins. Easement curves are recommended, as requiring neither a slacking of speed, below the limits given in the table, nor an excess of cant to cause easy riding. American practice on new construction is to lower the inner rail and raise the outer rail equal amounts, thus preserving the grade of the center line. On constructed roads it is customary to give the whole cant to the outer rail; though as this gives some grade resistance to the curve resistance it is not so good a rule as the first and ought not to prevail. The practical difficulties in the way of placing the cant where it theoretically belongs—in full amount and at the beginning of the curves, may be overcome as follows: Begin the elevation 50 to 100 ft. back of the P. C., on the tangent, and increase to the full theoretic amount at the P. C.; and in joining compound curves, make the cant at the P. C. C. a mean of those of the two branches; and use also easement curves at the ends of the simple curves.

THE PLANT LINE STEAMSHIP "LA GRANDE DUCHESSE."

(With full-page engraving.)

The Plant Line System, operating railways and steamship lines in the South, has recently added to its equipment the steamship "La Grande Duchesse," which was briefly mentioned in our issue of Dec. 3, 1896, and a general view of which is given in Fig. 1. The steamer is now running between New York and Savannah, Ga., a trip of 705 knots, the guaranteed speed being 17 knots per hour, and the time allowed for the voyage being 48 hours.

The steamer is 404 ft. long over all, 47 ft. 9 ins. beam, and has a displacement of 5,600 tons on a mean draft of 17 ft. 4½ ins. The hull is of steel, with Z-bar frames, and has a double bottom and nine watertight compartments. The deckhouses are of steel, and the state rooms are very elaborately equipped and finished, the equipment including telephone connection to a central station. There is a shade deck 350 ft. long, above which are carried the boats, including 12 lifeboats and the full number of life-rafts, in accordance with the government requirements. There are two pole masts. The rudder frame is of cast-steel, and is fitted with a submerged rudder of the form now used on the ships of the navy. A complete plant for the heating and ventilation of the cabins by the exhaust system has been installed, Sturtevant blowers being used for this plant as well as for the forced draft for the boilers. There is also an electric light plant, and electric, steam and hand-steering gears.

The steamer is propelled by twin screws, each driven by a quadruple-expansion, surface condensing, inverted, direct-acting engine of the marine type, with four cylinders, all the cylinders being bushed or lined. The screws are of manganese bronze, 14 ft. 6 ins. diameter, with hollow steel shafts made by the Bethlehem Iron Co. The main steam pipes are of steel, with the Smith patent expansion joints, the middle of the joint being fixed, and both engine and boiler sides of the pipe sliding on this. Steam is supplied by eight Babcock & Wilcox water tube boilers, placed back to back (four in a row) along the center line of the ship, as shown in Fig. 2. An elevation and cross-section of the two middle boilers of one set are shown in Fig. 3. Forced draft at 1-in. pressure on the water gage is employed, the air being delivered at both sides of the ashpits by pipes from the Sturtevant blowers. The working steam pressure is 225 lbs. per sq. in. The boilers have tubes 4 ins. and 2 ins. diameter, 7 ft. 3 ins. long, and the overhead drums are 43 ins. diameter and 12 ft. long, built of steel plates 19-32-in. thick, and having ¾-in. hydraulic forged heads. The weight of the boilers is about 295 tons, including pipes, fittings and water. The two firing rooms are at the sides of the ship. The coal is loaded into the bunkers from barges alongside by means of a hoisting conveyor driven by an 8-HP. electric motor, and is trimmed by four mechanical conveyors or trimmers across the bunkers.

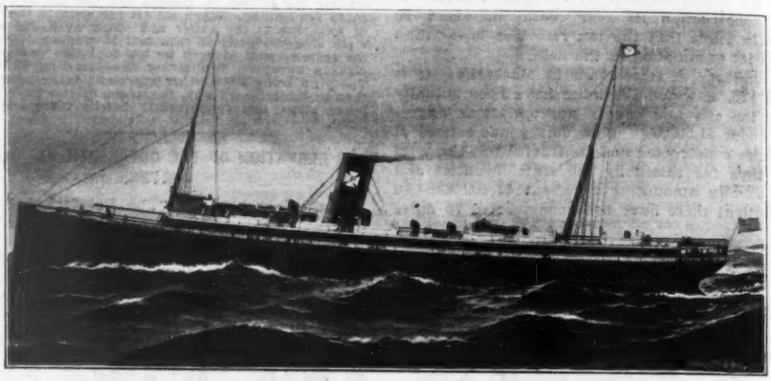


FIG. 1.—STEAMSHIP "LA GRANDE DUCHESSE;" PLANT LINE (NEW YORK AND SAVANNAH). Newport News Shipbuilding & Dry Dock Co.; Builders.

Iron buckets hung from trolleys on an overhead rail are used to carry the coal from the bunkers to the furnaces. All the flues lead to one large smokestack of oval section. There is a large equipment of Blake pumps, including boiler feed pumps, air pumps, bilge and air pumps, etc.

The vessel and the engines were built by the Newport News Shipbuilding & Dry Dock Co., of Newport News, Va. The boilers were built by the Babcock & Wilcox Co., of New York, and all the pumps were supplied by the George F. Blake Mfg. Co., of New York. Mr. Henry B. Plant is President, and Mr. J. W. Fitzgerald, of Port Tampa, Fla., is Superintendent of the Plant System. Capt. P. H. Hanlon is in command of the "La Grande Duchesse."

The general dimensions and particulars of this steamer are as follows:

Steamship "La Grande Duchesse"; Plant Line.

Length over all	404 ft. 0 ins.
Length between perpendiculars	380 " 0 "
Beam	47 " 9 "
Depth of hull	37 " 4 "
Draft, light	14 " 0 "
Draft, loaded	17 " 9 "
Displacement (mean draft of 17 ft. 4½ ins).	5,600.00 tons.
Gross tonnage	5,017.90 "
Net tonnage	3,006.28 "
Speed, guaranteed	17 knots.
Engines (two sets)	Quadruple expansion.
Cylinders, diameters	24, 34, 48 and 68 ins.
Cylinders, stroke	42 "
Boilers, eight	Water-tube.
Heating surface, total	21,000 sq. ft.
Grate area	550 " "
Boiler pressure	225 lbs.
Screws (two), diameter	14 ft. 6 ins.
Screws, pitch	18 " 0 "
Engine revolutions at normal speed	115 per min.
Coal capacity of bunkers	700 tons.
Freight capacity of hold	3,000 "
Passengers	700
Engineers and engineroom and fireroom staff	50
Total number of officers and crew	100

PROPOSED ELECTRIC PUMPING STATIONS FOR THE NEW ORLEANS DRAINAGE SYSTEM.

In our issues of Nov. 8, 1894, and May 30, 1895, we gave accounts of the proposed system of drainage of the city of New Orleans devised by an Advisory Board, the engineer members of which were Messrs. B. M. Harrod and Henry B. Richardson, of New Orleans, and Rudolph Hering, of New York city. The scheme included the establishment at seven different points in the city and its environs of low-lift pumping stations, named as follows: Broad, No. 1; St. Louis, No. 2; St. Bernard, No. 3; Lafayette, No. 4; Jourdan, No. 5; Metairie, No. 6; and Orleans, No. 7. A map in our issue of May 30, 1895, gives the locations of these stations.

At a recent meeting of the Board of Drainage Commissioners two reports were presented by Mr. B. M. Harrod, engineer to the Board, and a report by Mr. Alfred Raymond, electrician, discussing the question of the relative cost of operating the several pumping stations by steam power and by electric power furnished from one central generating station. The first report by Mr. Harrod makes a comparison of the relative cost of installation and operation by steam and by electric power of the first five of the seven pumping stations above named. As these estimates are prepared only to afford a fair basis for the comparison of costs three items are omitted from consideration, viz.: real estate, foundations for pump buildings, and pumps. In the case of the real estate and the foundations their amount cannot be exactly determined until bids are received, but it is apparent that the relative cost of these two items will to a considerable extent be in favor of electricity. We condense into tabular form below the items entering into the comparative estimate. The comparison for each steam pumping station is based on the following approximate data: Consumption of coal per HP. per hour, 3½ lbs.; cost of coal per ton, delivered, $3.25; cost of ordinary repairs and supplies, $1.20 per HP. per annum. Crews at stations Nos. 1, 2, 3 and 4, each: Chief engineer, $1,500 per annum; assistant, $900; two oilers, $1,200; fireman, $600; wheeler, $540; helper, $540; total, $5,280; to which is added for station No. 5 an additional fireman, wheeler and helper, making the total for that station $6,960. Cost of erection and installation of buildings and plant, exclusive of real estate, foundations and pumps, $85 per HP. Interest and depreciation are each taken at 5% of cost.

Cost of Steam Pumping, New Orleans Drainage.

Station No.	1	2	3	4	5	
Horse-power	720	810	555	885	1,988	
HP. hrs. per yr.	471,212	787,000	801,156	1,155 785	3,101,649	
Cost:						
Erection, etc.	$61,200	$68,850	$47,175	$75,225	$168,980	
Coal	2,680	4,476	4,557	6,575	17,643	
Reprs, supplies	864	972	666	1,062	2,385	
Crew	5,280	5,280	5,280	5,280	6,960	
T'l operat'g...	8,824	10,728	10,503	12,917	26,988	
Int. & depreciatn	6,120	6,885	4,718	7,522	16,898	

Summary.

Cost of erection and installation.	$421,430
" " operation, per annum.	69,960
" " interest and depreciation, per annum	42,143

Central Station for Electric Power.

Cost, 5,568 HP. engines, boilers, stack, &c., at $80	$445,440
" 4,176 K-W. generators, at $20	83,520
" operating 8,115,000 HP. hours, based on 2¾ lbs. coal per HP. hr.; coal, $2.75 ton	30,684
" repairs, supplies, etc.	6,681
" wages	9,960
Total operating cost, Central Station	$47,325
Interest, 5% on $528,960	$26,448
Deterioration, steam plant, 5% on $417,600	20,880
Deterioration, generators, 2% on $83,520.	1,770
	49,098

Cost of Pumping at Electric Stations.

Station No.	1	2	3	4	5
Motors, kilowatts	581	653	450	713	1,100
Motors, cost at $22.	$12,782	$14,366	$9,900	$15,686	$24,200
Line, cost	3,000	2,400	2,000	3,700	9,000
Bldgs. at $6 per HP.	4,644	5,226	3,600	5,706	8,802
Total, installation.	$20,426	$21,902	$15,500	$25,092	$42,002
Cost of wages*	1,500	1,500	1,500	1,500	1,500
Interest, etc.**	1,568	1,695	1,193	1,926	3,204

*Supplies, nominal. **5% on building, 2% on motors and line.

Summary; Electric Pumping Station.
(Including Central Station.)

Erection and installation	$653,072
Cost of operation	54,825
Interest and depreciation	58,684

General Summary.

	Cost for—Steam.	Cost for—Electricity.	Excess for—Steam.	Excess for—Electricity.
Construction	$421,430	$653,972	.....	$232,542
Operation	69,960	54,825	$15,135	.....
Interest and dep.	42,143	58,684	.....	16,545

In the calculation of the electric plant the losses were assumed as follows: In the generators, 7%; in the five, 10%; in the motors, 7%. The wages of the crew at the central station are, per month, 1 chief engineer, $175; 2 assistants, $200; 2 dynamo men, $120; 2 oilers, $100; 2 firemen, $100; 2 wheelers, $90; 1 helper, $45; total, $830 per month, or $9,960 per year. In each of the electric pumping stations the crew consists of one man at $65, and one at $60 per month, making the yearly cost $1,500.

The second report of Mr. Harrod gives a comparative estimate based on the erection and partial operation of stations Nos. 2, 6 and 7. We condense this estimate below:

Estimate for Steam Pumping.

Station No.	2	6	7
HP. when completed	1,080	1,561	1,457
Foundations, covering, sq. ft.	7,500	5,200	4,000
" cost, $5.80 pr sq. ft	$43,500	$30,100	$26,680
Boiler house, at $15 per HP.	16,200	23,415	21,855
Engines, HP.	283	1,100	1,214
Cost at $40 per HP.	$11,320	$44,000	$48,560
Auxiliary engines at $5.	1,415	5,500	6,070
Boilers and aut. stokers, HP.	283	1,100	1,214
Cost at $25 per HP.	$7,075	$27,500	$30,350
Drainage pumps	3	4	4
Cost at $7,000	$21,000	$28,000	$28,000
Approach, suct'n & dis. basins.	32,800	12,228	12,228
Total cost	$133,310	$170,803	$173,743

Central Station for Electric Power.

Foundation and building for boilers, engines and dynamos for 3,312 HP. estimated at	$35,000
Engines, piping, pumps, etc., 3,312 HP. at $40.	132,480
Boilers and automatic stokers, 3,312 HP. at $25	82,800
2,484 K-W. generators, at $20.	49,680
Total	$299,960

Electric Pumping Stations.

Station No.	2	6	7
Foundations for buildings, motors and pumps, for HP.	1,080	1,561	1,457
Covering, sq. ft.	6,000	4,160	3,680
Cost at $5.80 per sq. ft.	$34,800	$24,128	$21,344
Motors, K-W.	217	887	978
Cost, at $22 per K-W.	$4,774	$19,514	$21,516
Line	1,800	18,460	10,744
Pumps	21,000	28,000	28,000
Basins	32,800	12,228	12,228
Total	$95,174	$102,300	$93,832

Cost of Operation, Steam Power.

Station No.	2	6	7
Net HP.	283	1,100	1,214
HP. hours work per year	98,484	1,003,200	755,108
Cost of coal*	$539	$5,704	$4,292
Cost of crew	5,280	5,280	5,280
Rep. and supplies ($1.20 pr HP.)	340	1,320	1,457
Total	$6,179	$12,304	$11,030

*3½ lbs. per HP. hour and $3.25 per ton.

Cost of Operation, Electricity.

Central and Nos. 2, 6 and 7 Stations, 2,385,363 HP. hours, @2¾ lbs. coal = 3,279 tons.	
3,279 tons coal @$2.75	$9,017
Supplies and repairs, 3,312 HP. @1.20	3,974
Crew, central stations	5,280
Crews of motormen, 3 stations, @$1,500	4,500
Total	$22,771

General Summary.

	Cost per annum.—Steam.	Electricity.
Station No. 2	$6,179	$1,500
" " 6	12,304	1,500
" " 7	11,039	1,500
Central station		18,271
Total	$29,522	$22,271

In addition to the above estimates of comparative costs of operation by steam and by electric power and of the cost of installation, the report includes estimates of cost of certain canals required by the drainage plant, which foot up to $823,400. This figure is the same whichever system of pumping is used.

The report of Mr. Raymond, the electrician to the Board, gives a statement of the well-known advantages of electric transmission from central stations as compared with separate small steam plants. He believes that actual results will show greater differences in favor of electricity than are shown in the estimates.

At a subsequent meeting of the Board of Drainage Commissioners, held on Mar. 15, it was decided to adopt the plans and specifications of Mr. Harrod for the construction of electrical pumping stations Nos. 2, 6, and 7, with their accompanying canals, and for the erection of a central electrical plant. The work is to be advertised for 30 days, and will cost about $1,200,000. The advertisement for bids will be found in our advertising columns. It calls for bids for pumping stations operated by either steam or electric power.

COMPOUND FREIGHT LOCOMOTIVE; NORTHERN PACIFIC R. R.

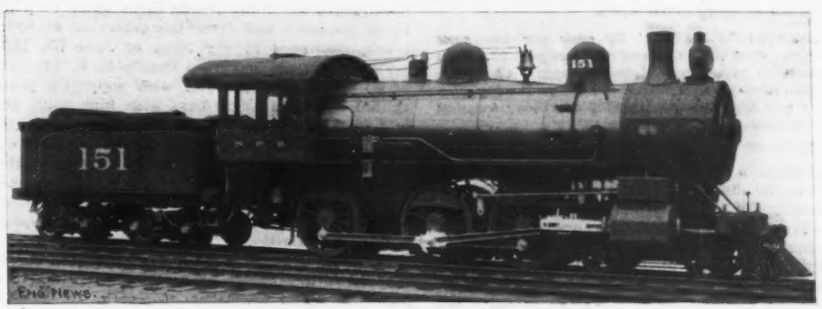
Two very large freight locomotives have recently been built for the Northern Pacific R. R., the general design and details of which were worked out by Mr. E. M. Herr, Superintendent of Motive Power, in consultation with the Schenectady Locomotive Works, Schenectady, N. Y., and we illustrate herewith one of these engines, the cut being reproduced from a photograph sent us by the builders.

The engines are of the ten-wheel type, on the two-cylinder compound system, and are fitted with the builders' design of intercepting valve, which enables the engine to be operated either simple or compound. In general appearance they resemble the huge mastodon helper engines built at the same works for the same railway and illustrated in our issue of Feb. 25, but have driving-wheel loads of 21,000 lbs. per wheel, while the latter have 18,750 lbs. per driving wheel. These ten-wheel engines have exceptionally large boilers, with a heating surface of nearly 2,900 sq. ft. All the details were designed with a view to obtaining the maximum heating surface of boiler with a given weight, and in order to accomplish this, cast, forged and pressed steel have been extensively used in place of cast and wrought iron. They are of standard gage, and designed to burn bituminous coal as fuel. The pistons have cast iron packing rings sprung into place, and the piston rods and valve stems have the Jerome metallic packing. The slide valves are of the Allen-American pattern. The piston rods are extended through the front cylinder covers, the valve rods are inclined, and the main and side rods are of I-section. The driving wheels have centers of American cast steel, with the steel tires secured by shrinkage, and the driving boxes are also of cast steel. The truck wheels have spoke centers and steel tires. The boiler barrel and firebox plates are of carbon steel, and the barrel has double riveted circumferential seams and butt joint horizontal seams, sextuple riveted, with welt strip inside and outside. The firebox is supported on the frames by rocking links. It has radial stays 1⅛ ins. diameter, and the staybolts are of Uister iron, 1 in. diameter. The boiler is clothed with Sall Mountain asbestos. The tubes are of charcoal iron, of No. 12 W. G. A firebrick arch is fitted in the firebox, being supported on four water tubes of the railway company's style, and the rocking grate is also of the railway company's style. The ashpan is sectional. A single high exhaust pipe is used, with nozzles 5¼, 5½ and 5⅝ ins. diameter. The boiler feed is supplied by two Sellers injectors. The tender has cast-iron plate wheels, carried in channel iron truck frames, the front and back trucks having center bearings and the rear truck having additional side bearings. The tender frame is of 10-in. steel channels.

The fittings include three 3-in. Ashton safety valves (2 open pop and 1 cam lever valve), two Sellers injectors, the McIntosh blow-off cock, Kewanee reversible brake beams, Dean's sand feeding device and a 16-in. Star headlight, with round case. The American brake, operated by air, is fitted to all the driving wheels, and there is the Lechatelier water brake on the cylinders and the Westinghouse automatic air brake on the tender and for the train, the air being supplied by a 9½-in. air pump. The Westinghouse air signal is also fitted. We are informed that one of the engines developed about 1,200 HP. while operating compound on the grade out of Schenectady, pushing freight trains, and that the operation during the test was entirely satisfactory, working both compound and single. The following table gives, in our standard form, the leading dimensions and particulars of these engines:

Ten-Wheel, Two-Cylinder Compound Freight Locomotive; Northern Pacific R. R.

Running Gear:	
Driving wheels, diam.	5 ft. 3 ins.
Truck " "	2 " 6 "
Tender " "	2 " 9 "
Engine truck	Swing bolster
Journals, driving axles, main	9 × 11 ins.
" " front and back	8½ × 11 "
" truck axles	6 × 11 "
" tender axles	4½ × 8 "
" main crank pin	6½ × 6 "
" side rod pins, main	7 × 5¼ "
" side rod pins, front and back	5½ × 4½ "
Wheel Base:	
Driving and rigid	14 ft. 10 ins.
Total engine	25 " 11 "
" tender	15 " 3 "
" engine and tender	52 " 9½ "
Total length of engine and tender	61 " 4½ "



TEN-WHEEL, TWO-CYLINDER COMPOUND FREIGHT LOCOMOTIVE, NORTHERN PACIFIC R. R.
Schenectady Locomotive Works, Builders.

Weight in Working Order:	
On driving wheels	126,000 lbs.
On truck wheels	46,000 "
Engine, total	172,000 "
Tender, empty	37,800 "
Cylinders; h. p.	22 × 26 ins.
" l. p.	34 × 26 "
Pistons, horizontal thickness	4¾ and 5¾ "
Piston rod, diam.	3¾ "
Form of crosshead and guides	Two-bar
Valve Gear:	
Ports, steam h. p.	2½ × 20 ins.
" " l. p.	2½ × 23 "
Ports, exhaust, h. p.	3 × 20 "
" " l. p.	3 × 23 "
Bridges	1⅞ "
Lap, outside, h. p.	1¼ "
" " l. p.	1¼ "
Clearance, inside, h. p.	⅛ in.
" " l. p.	⅛ in.
Maximum travel of valves	6¼ ins.
Boiler.—Type	Extended wagon-top
Diam. of barrel inside	5 ft. 10 ins.
Thickness of barrel and fire-box plates	11-16, ¾, ⅝, 9-16 and ½-in.
Working steam pressure	200 lbs.
Firebox: Type	Radial-stayed
Length inside	10 ft. 3-16 in.
Width inside	3 ft. 5 ins.
Depth at front	7 " 0 "
Depth at back	5 " 11½ "
Thickness of side plates	5-16-in.
" back plate	5-16-in.
" crown sheet	⅜-in.
" tube sheet	½-in.
Grate area	34.22 sq. ft.
Staybolts, diameter	1 in.
Water space, width, front	4½ ins.
" " " sides, above grate	3½ to 4 "
" " " back, at crown	3½ to 4 "
Tubes, number	378
Diameter	2 ins.
Length over tube plates	13 ft. 6 "
Heating Surface.	
Tubes	2,655.4 sq. ft.
Firebox	208.0 " "
Water tubes	32.1 " "
Total	2,895.5 " "
Miscellaneous.	
Exhaust nozzle, diameter	5¼, 5½ and 5⅝ ins.
Smokestack, diameter at top	1 ft. 6 "
Smokestack, diameter near bottom	1 " 4 "
Smokestack, height from rail to top	14 ft. 10½ "
Capacity of tank	4,350 gallons
Capacity of coal space	18,000 lbs.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes in standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The decision of a majority of the U. S. Supreme Court to the effect that the Trans-Missouri Freight Association is a transgression of the Sherman Anti-Trust law is universally conceded to be of far-reaching effect and to settle definitely and finally the question as to whether the railway traffic association's agreements restrain, limit or regulate competition in violation of law. We are of the opinion that the judgment of the Court is entirely sound. It had no right to do anything else than take the law as it found it. That the framers of the Sherman anti-trust law meant to prevent and annul just such combinations as the railway traffic associations, there is no reason to doubt. If they did this without transgressing constitutional requirements, the Court had no option but to uphold the law. That the Sherman law and the anti-pooling clause of the Interstate Commerce law are unwise in so far as they prevent the railway companies from organizing for the maintenance of fair, reasonable and stable rates, is a proposition on which all unprejudiced students of the question agree. But these acts are on the statute book; the courts have now affirmed their validity; in the present state of public opinion there is probably very little chance of securing their repeal; what, then, are the railway companies to do?

As the answer to this question in detail will probably absorb the best energies of the greatest lawyers of the country for some time to come, it would be unwise to attempt any extended discussion here. One or two cardinal facts, however, it may be worth while to lay down. The law may punish a man or a corporation for committing an act; but it cannot compel him to commit an act against his will. If two rival country merchants take it into their heads to quit competing with each other, no law that could ever be placed on a statute-book could force them to cut each other's prices or sell goods at a lower price than they choose to sell them. So if two railway corporations choose to do business without competing, no lawmaker or law enforcer can compel them to cut each other's rates, send out hustling agents to bid for each other's business or perform any of the other acts which constitute real competition. We fully realize that there are practical difficulties in the way of carrying out such a policy in the business of railway transportation; but if the alternative is a cut-throat slashing of all rates of fare and freight, with all roads animated with the sole object of "getting the business," at any cost, then these practical difficulties will have to be met and overcome.

The fact is that if the unrestricted competition which the lawmakers are striving to bring about could once be put into effect, the inevitable and speedy result would be the permanent end of all competition. The only alternative to the destruction of the value of all railway property would be the consolidation of all the railways into a few great corporations, each in sole control of a certain section of the country, so mapped out as to do away with the possibility of competition. This is what the anti-trust and anti-pooling laws will bring about if they are rigidly enforced. Is this the end which those who framed these measures desire?

The increase in driving wheel loads of locomotives goes merrily on, keeping pace with the construction of larger and larger engines all the time. In our issue of Feb. 25 we described a monster twelve-wheel locomotive for the Northern Pacific R. R., and this week we describe a ten-wheel engine for the same road, which with a slightly lower total weight, has an even greater load per driving wheel, as shown by the following comparison:

Engine.	Total wt., lbs.	Wt. on drivers, lbs.	Wt. on driver, lbs.
12-wheel	186,000	150,000	18,750
10-wheel	172,500	126,000	21,000
Difference in latter.....	— 13,500	— 24,000	+ 2,250

These great loads naturally give rise to some speculation as to the tracks upon which they are to be imposed, and from the tables of standard track, published in our issue of June 25, 1896, we find that the Northern Pacific R. R. has rails of 56 and 66 lbs. per yd., with supported joints spliced by 24-in. angle bars with four bolts, and laid on 17 ties to a rail length, these ties being of oak, tamarack and fir. It has been pointed out pretty frequently of late that locomotive weights are in many cases being increased beyond the reasonably safe capacity of the track, and it may be questioned whether the track side of the question has received due attention in the design of these engines for the Northern Pacific R. R. In a table of dimensions of heavy locomotives in a paper on "The Relations of Track to Traffic," recently read before the New York Railroad Club, we find but few engines having loads of over 20,000 lbs. per driving wheel, the maximum being 23,800 lbs. on an experimental eight-wheel express engine of the Pennsylvania R. R., and 24,000 lbs. for a single driver express engine on the Philadelphia & Reading R. R. Freight engines are usually kept down to driving wheel loads of 17,000 to 18,000 lbs. as a maximum. It may be noted that these new ten-wheel engines have this load of 126,000 lbs. imposed on a driving wheel base of only 14 ft. 10 ins.

The paper of Messrs. N. W. Lord and F. Haas on the calorific value of certain coals, which we print in abstract elsewhere in this issue, is, we think, one of the most valuable papers on the heating value of coal that has yet appeared in this country. The best earlier work of the kind described in this paper was that of M. Mahler, in France, some six years ago, but until the appearance of the paper now before us, it was not known whether or not the conclusions drawn from Mahler's experiments would apply to American coals. In fact, by some authorities this was emphatically denied. One of the chief conclusions from Mahler's work was that the heating power of all the coals tested by him, as determined by his calorimeter, agreed with the result calculated from the ultimate chemical analysis, using the Dulong formula, within a maximum limit of 3%, the average results agreeing within 0.4%. Messrs. Lord and Haas now show that the same conclusion may be drawn from their tests; that is, that in 40 tests the maximum difference between the heat calculated from the ultimate analysis and that determined by the Mahler calorimeter is 2% of the total calculated heat, the minimum difference 0.1%, and the average difference 0.3%.

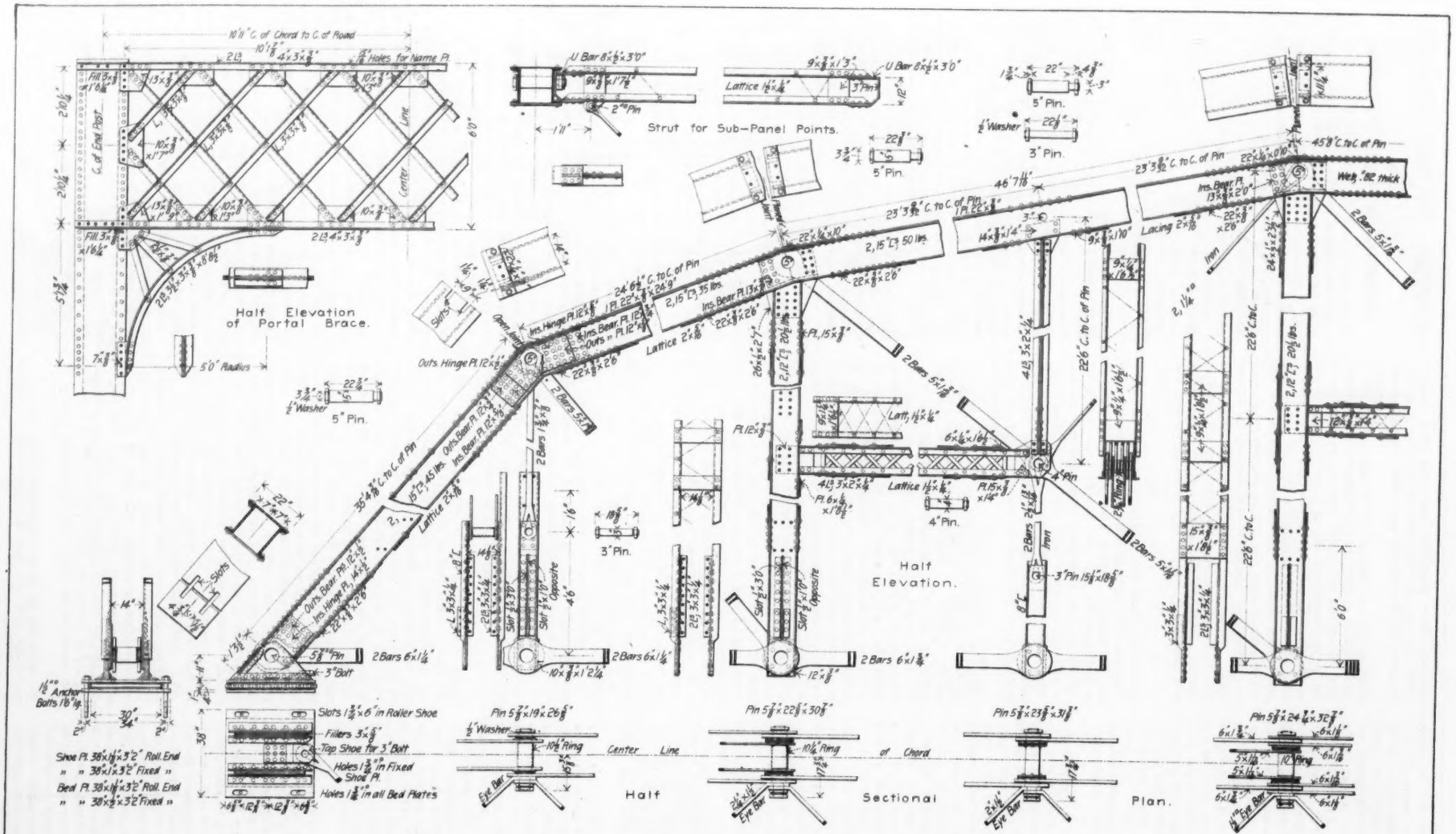
Another most important result of the tests described in this paper is that the fuel value per pound of the combustible portion of the coal of any one seam is uniform throughout the extent of the seam within certain limits of area, which limits no doubt differ in different seams. Thus the Upper Freeport coal, extending for 80 or 90 miles, has a uniform heating value per pound of its combustible matter within a maximum variation of 2.6%, while the Middle Kittanning coal in Lawrence Co., Pa., has a uniform value throughout that district, but altogether different value in Hocking Co., O. The practical bearing of this fact is that if we know the seam and the district any given lot of coal comes from, we need only to determine its ash, sulphur and moisture to predict its heating value within a very small limit of error. An objection may be made to the paper of Messrs. Lord and Haas that it does not contain a sufficient number of determinations from which to draw general conclusions, but it is to be hoped that their work will be supplemented and verified by work done in other states covering a greater variety of coal.

A decision of considerable interest to contractors was recently announced by the U. S. Circuit Court of Appeals at St. Louis, in the case of Hugh Murphy vs. The Colorado Paving Co. Bids were received some two years ago for paving a section of Broadway in the city of Denver with asphalt, and the lowest bidder was Hugh Murphy, who bid $48,563. The Board of Public Works, however, awarded the contract to the Colorado Paving Co. at its bid of $54,448. The charter of the city provides that contracts must be awarded to the lowest bidder, and Mr. Murphy brought suit to compel the award to him of the contract. The court of appeals, however, denied the application, holding that the requirement that contracts shall be let to the lowest bidder was enacted for the protection and benefit of the taxpayers and not of the contractors. Any taxpayer might sue to compel an award to a lowest bidder, but a contractor has no standing in court. The principle on which this is based was set forth as follows in the suit of Strong vs. Campbell.

> Whenever an action is brought for a breach of duty imposed by statutes, the party bringing it must show that he had an interest in the performance of the duty, and that the duty was imposed for his benefit. But where the duty was created or imposed for the benefit of another, and the advantage to be derived to the party prosecuting, by its performance, is merely incidental and no part of the design of the statute, no such right is created as forms the subject of an action.

A grade of 15% was stated in a recent issue of the "Electrical Engineer" to be in use on an electric railway in Pittsburg, Pa., the "Hill-top" division of the Pittsburg & Birmingham Traction Company's lines, which was recently opened for traffic. Mr. W. H. Rogers, Assistant Secretary of the company, writes us that this grade is 9½% instead of 15%. There is about 600 ft. of track on this grade, and in a total distance of 6,000 ft. the grade averages 4%, and 2,000 ft. of the distance has a grade of 9%. The cars run on this line have single trucks, equipped with two 50-HP. Westinghouse motors. The weight of each car, with the equipment, is about ten tons. For the sake of the lives and limbs of innocent Pittsburgers, we are glad the reported operation of its electric cars on a 15% grade proves false.

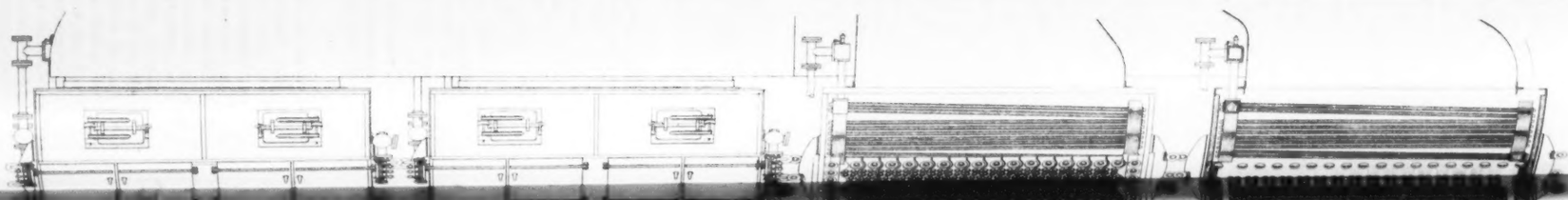
When arc lights were first introduced for street lighting, there was a very exaggerated idea of their lighting power. A light of 1,000 candle power seemed such a powerful illuminator that the idea was very naturally conceived of placing lamps on the top of tall towers and lighting the whole area of a city. Several municipalities adopted this tower system of lighting, of which the best known example is doubtless Detroit. It was at once found, however, that a cluster of arc lamps 150 ft. or more from the ground might be an excellent plan for lighting the whole of a large area; but was a very poor plan for lighting city streets. In the average American city, with long blocks, the streets comprise not more than one-third of the area. Hence with the tower system of lighting 66% or more of the illuminating power is wasted in lighting up house roofs, back yards and vacant lots. Nearly every city of which we have information that originally adopted the tower system of light-

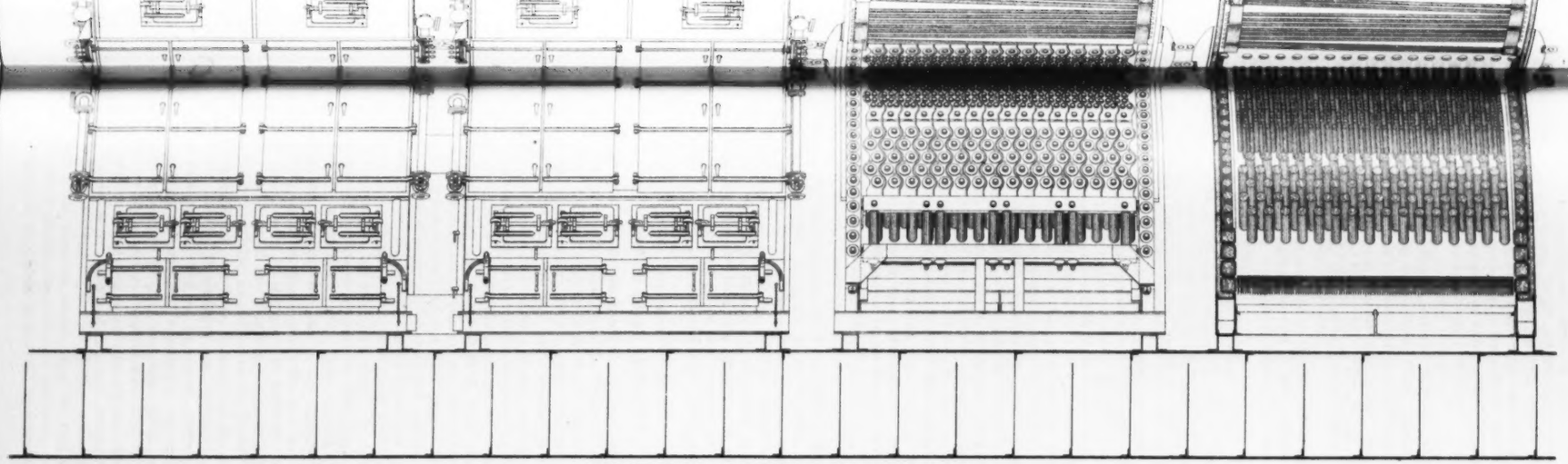


LONG SPAN HIGHWAY BRIDGE AT LIVERMORE FALLS, MAINE.

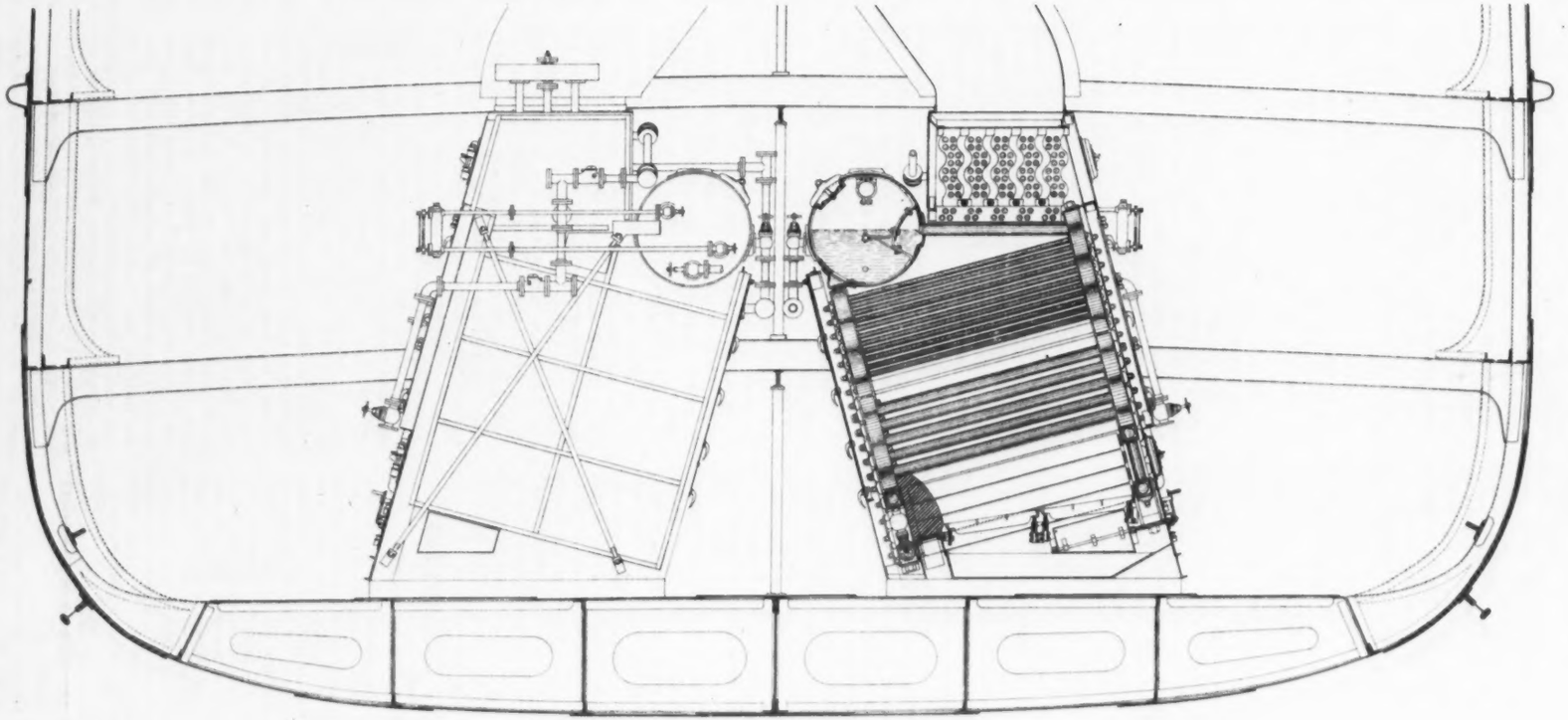
Massillon Bridge Co., Massillon, O., Contractors.

Chas. A. Mixer, M. Am. Soc. C. E., Engineer in Charge.





LONGITUDINAL SECTION THROUGH FIRE ROOM.



ATHWARTSHIP SECTION.

FORGED STEEL WATER TUBE BOILERS FOR THE STEAMER "LA GRANDE DUCHESSE," PLANT STEAMSHIP LINE.

The Babcock & Wilcox Co., New York City, Contractors.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

ing has abandoned it. It is therefore quite surprising to learn that Des Moines, Ia., proposes to put in a municipal street lighting plant and to use the tower system. What consideration influenced the city authorities to adopt this system, we do not know, but we would strongly urge them to investigate the experience of Detroit and other cities with the tower system of lighting before they construct such a plant in their own city.

We have received a printed copy of Bill No. 1,166, introduced in the New York Assembly on Feb. 24. Section 1 of this bill is as follows:

Section 1. No crushed, pounded or broken stone which contains more than twenty per centum of lime or magnesia in any form shall be used in the construction, improvement or repair of any street, road or highway in any city or village within this state.

The remaining sections of the bill contain merely provisions to carry Section 1 into effect. The sheet on which the act is printed carries at its head the following:

Sustain this bill. The use of stone containing a large percentage of Lime or Magnesia is very injurious. It destroys Paint, Bicycles, Wagons, Furniture, Etc., and produces diseases of the skin and eyes; often causing total blindness, and is already forbidden in Counties of less than 200 square miles, by Chapter 555, Laws of 1890. Help the cause of good roads by assisting to make this a law.

In response to the above appeal we take pleasure in saying that of all the foolishness ever perpetrated in the name of "Good Roads" this is the most absurd that has ever come to our knowledge. The statements made in support of the bill are such ridiculous falsehoods that it is hardly thinkable that anyone of intelligence can be misled by them. Instead of "helping the cause of good roads," this bill, if made a law, would prevent towns located in limestone regions from building macadamized roads. It would even prevent the use of limestone in making concrete foundations for pavements. Doubtless the bill will be buried in a committee and never heard of again; and we mention it here merely as a remarkable example of the foolish measures which are at times brought forward in almost every legislative body.

In our issue of Jan. 21, in an article describing the wire-screen grate for steam boilers, invented by Mr. G. C. St. John, we gave the results of some tests of the Edgar vertical boiler with this grate. Mr. E. F. Edgar, of the Edgar Boiler Co., Ltd., informs us that the figures we gave for evaporation from and at 212° per lb. of combustible in these tests, should have been per lb. of coal.

COUNTRY ROAD LEGISLATION.

In this issue is presented an interesting general digest of road legislation in the United States, prepared by Prof. Van Ornum, of the Department of Civil Engineering, Washington University, St. Louis. The necessity for improvement in highway construction in this country is now very generally recognized; but the actual improvement progresses slowly and is practically confined to a very few states. From the paper of Prof. Van Ornum, it is very evident that adequate road laws, adapted to present conditions and equitably apportioning the cost of such construction, are yet wanting in the majority of the states. Laws proposing to regulate or to promote the building of country roads are abundant enough, but they are generally either out of date or so crude in form as to fail utterly in application. Prof. Van Ornum contends that the only remedy lies in the direction of intelligent engineering supervision and control and a just division of the expense between the state, the county and the abutting lands, with this expense distributed according to the benefits. This is practically the plan followed in the states of New Jersey, Massachusetts, Connecticut and Rhode Island, where improved highway construction has received substantial encouragement and has made general progress. Each of these states has a highway commission, made up of expert and competent men who advise and control in matters of construction; and, while the laws differ considerably in detail, the general principle is the same in recognizing the fact that the mass of improvement of this character is for the benefit of the public in general, and that it is not right to impose the whole burden of better roads upon the owners of abutting lands.

The chief stumbling block in the way of a general development in better highway construction is the cost of undoing the bad work of past generations, in the location and construction of these roads, and the enormous aggregate mileage of our roads. The legislatures of the several states are largely made up of the representatives of the farming class of citizens, and so long as the burden of cost falls upon the farmers, we can naturally expect little encouragement from the men they elect to office. On the other hand, the larger towns and cities object to being taxed for a road improvement in some remote portion of the state, and it is evident that some adjustment of interests is necessary before any real progress can be made. The fact yet to be generally appreciated is that better roads tend towards the greater prosperity of the whole community, and are for the benefit of the public in general, as is now held by the courts of Pennsylvania. This means that the cost of their construction should be equitably distributed among all the people benefited. A decided state interest in such development also favors what is quite as essential, the intelligent planning and supervision of new construction and repairs, for the state can better provide the necessary machinery for this work than any county or isolated community.

But what the people want, and what is needed to encourage development in road construction and to provide the object lesson in actual benefits to be derived which will lead to further development, is a type of ordinary highway that is intelligently designed and yet cheap to construct. A country road costing $5,000 or more per mile is simply prohibitory in price anywhere except in the immediate vicinity of large cities and in wealthy communities. A road 9 ft. wide, covered with a well-rolled 4-in. layer of good hard rock and dirt from along the road, costs only from $600 to $1,000 per mile and is sufficient for the mass of country travel. Roads of this type can be built by the public without imposing undue taxes.

It may be noted here, however, that there is a certain tendency in current "good road" literature to exaggerate the value of good roads to the farmers and their effect in increasing the value of farm lands. The story has gone broadcast and been repeated in hundreds of journals how certain counties in New Jersey spent a half million or more in good roads and doubled the price of their real estate in consequence, and this is held up as an example of the benefit of good roads to the owners of farm lands. But the counties above noted are practically outlying and rapidly growing suburbs of New York city, in which the value of property is increasing anyway by leaps and bounds. In any such section good roads are enormously valuable unquestionably; they are an attraction to the suburban dweller, and they greatly increase the value of the farming lands contiguous to these suburban towns which to a large extent are really market gardens.

Sections of country so situated need costly highways and can afford to pay for them; but the more remote communities can not afford them and will find their immediate wants met by the cheaper construction referred to above.

Again, in the framing of road laws, there is something else to be considered, quite as important as the encouragement of cheap roads, and that is the decided discouragement of narrow wagon tires. It is evidently the worst type of economic folly to expend large sums in constructing good roads and then to permit these roads to be used, or rather abused, by vehicles which often concentrate from 2 to 5 tons on tires only 2 ins. wide. The destruction of the roadbed is inevitable in time, however well it is built, and the maintenance account is enormously increased. New Jersey is taking decided steps in this connection, by providing for a rebate of taxes up to $1 per wheel for wagons having tires over 4 ins. in width, and by lately permitting cities and towns to pass ordinances absolutely prohibiting the use of their streets by narrow tires supporting heavy loads.

Narrow tires are wrong in principle, even when used on dirt roads. In experiments made on the U. S. Road Exhibit at the late Atlanta Exposition, it was shown that just twice as much power was required to haul a load over a wet clay road cut up by 2-in. tires, as to pull the same load over the same road rolled and consolidated by 4 to 5 ins. tires. Foreign countries, where good roads are the rule and not the exception, recognize the value of broad tires in the transport of heavy loads and make their use compulsory. French market wagons, for example, have tires ranging in width from 3 to 10 ins., according to load, and the tires are usually from 4 to 6 ins. wide. A general rule laid down in Ontario, Canada, is that for wagons without springs no tire should be less than 2½ ins. wide for a load of 500 to 1,000 lbs. on each wheel, and not less than 6 ins. wide for loads of 2,000 to 3,000 lbs. on each wheel. The French practice of making the front axle shorter than the rear one, so that the two sets of wheels may not follow in the same track, is another excellent provision, as it converts the broad-tired wagon into an efficient road-roller. As near as we can learn the state road laws, with the exception of New Jersey, deal very lightly, if at all, with this question of broad vs. narrow tires; and as the expense of making the change would generally fall upon the owners of heavy wagons, this fact may explain the reluctance of legislators to discuss this question. But it is a subject that must be taken up and firmly dealt with, if road improvement is to be developed upon economic and intelligent lines.

Broadly stated, the requirements of a general road law would seem to be: A state highway commission made up of experts in road construction; a classification of roads in type and cost according to their importance as lines of travel; a distribution of the expense of construction between the state, the county and the individuals benefited, and stringent laws controlling the construction, maintenance and use of such roads and highways. The details of the road laws would necessarily vary with the resources, geological formation and actual needs of the several states. But where anything is done in this direction the necessity for intelligent expert control should be a first consideration; so that what is done may be in the direction, at least, of permanent and substantial improvement. By the lack of system and intelligent supervision in the past we have wasted many millions on our country roads with little or no lasting result. We now have an abundance of trained men ready to tell us what we can and should do in road construction; we must have these roads in time; and if our legislators will cast aside old usage, and a dread of the results of ignorance and prejudice on the part of their constituents and earnestly work for the general good of the whole community, we will at least make a speedy and intelligent beginning in the good work. The further and proper development will follow in the natural course so soon as we have enough of better roads to teach the masses the true public value of the improvement.

LETTERS TO THE EDITOR.

Efficiency of Built-up Wooden Beams.

Sir: Since the appearance in your columns of my article under the above caption I have received from engineers and others various letters inquiring for further particulars, asking when the full report of these tests will be issued, suggesting further experiments, etc. I therefore desire to state that I have by no means completed my investigations on this subject, and that no report will be issued until the work is finished. Owing to other duties which almost completely occupy my time I am unable to state how soon the work can be completed. From time to time results up to date will be printed. Meantime, I shall be glad to furnish to those wishing it more detailed information, and to receive any communications containing inquiries, suggestions, or experiences with built-up beams of any kind. Truly yours, Edgar Kidwell.

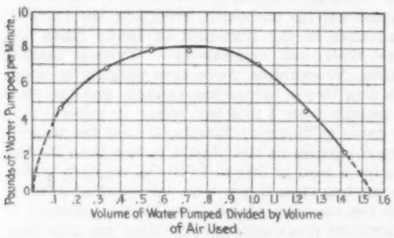
Michigan Mining School, Houghton, Mich., March 10, 1897.

Experiments to Determine the Efficiency of the Air-Lift Pump.

Sir: A short time ago I needed information in regard to designing a Pohle air-lift pump, but found that there was so little information to be obtained anywhere that I began some experiments upon a model pump. I am not yet ready to give the results of my work to the public:

but in connection with the article printed in your issue of March 4 the enclosed diagram showing the results of one of my experiments may be of passing interest to your readers.

These experiments were made with a lift distance from the surface of the water to the top of the discharge pipe,



Curve of Efficiency of Pohle Air Lift Pump, Deduced from Experiments with a Model.

of about one fourth of the immersion distance from the surface of the water to the point of admittance of the air.

The immersion was about 24 ins., and the lift about 6 ins.

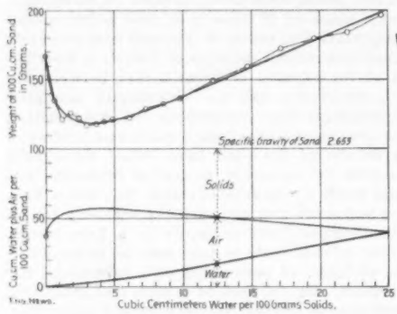
It will be seen at once that too much air or too little air supplied to the pump diminishes the capacity.

Yours very truly, J. H. Kinealy.

Washington University, St. Louis, March 13, 1897.

Voids in Wet Sand.

Sir: The accompanying curves give a good general idea of the relation of the water in sand to its weight, and of the relation of the water to the voids in the sand.


Weight of 100 Cu.cm. Sand in Grams.
Specific Gravity of Sand 2.653
Solids
Air
Water
Cu.cm. Water plus Air per 100 Cu.cm. Sand.
Cubic Centimeters Water per 100 Grams Solids.

They indicate possible sources of error in problems concerning volumes of mortar. For instance, if in estimating quantities of mortar, the sand and cement in which are measured by volume, the volume of the solids, forming the sand, used in the estimate, is the volume of the solids when the sand is dry, an error will be made amounting to perhaps 20% of the volume of the sand, if the sand used in the work contains on an average about 3% of water. The curves, observe the large numerical value of $\frac{dy}{dx}$ for the left hand ends of the two upper curves, also indicate sources of error, or possible causes for lack of uniformity in results in cement testing.

W. L. Garrels.

March 15, 1897.

The Action of Cinder Concrete on Steel.

Sir: In answer to the query of Mr. Thomas J. Foster, in your issue of Jan. 28, I would refer him to a report issued in 1895, by a commission appointed by the city of Hamburg to investigate the behavior of iron columns subjected to fire. This report says:

Of the many concretes tested the one found to be nearest fireproof was a mixture of one cement to six parts of crushed furnace slag, without sand; but unlike the other concretes tried, it was found to protect the iron for little more than two years, as the iron rusted, and this action was hastened by the acids contained in the slag.

To keep the iron free from rusting it must be completely embedded in the cement, in close contact on all sides and with absolutely no vacant spaces. To be sure of this it would be advisable to give the iron a coating of pure cement, without sand. This is done in the Monier construction by giving the wire net a covering of pure cement, which serves both as a protection to the iron and a binder between the iron and the mortar.

That the alkalies in the cinder will cause rusting, as suggested by the editor, is only true to the following extent: The alkalies will destroy the oil paint on the iron, and with this protection gone rust will soon follow. But alkalies are never the immediate cause of rusting, and by absorbing the oxygen will, on the contrary, practically arrest it. The portions of coal cinder and soot that are soluble in water have an alkaline reaction and will destroy any oil paint. This is seen in the effect of cinder and soot thrown out of the stacks of a locomotive and from chimneys of houses and factories; when these fall on iron or tin roofs the paint is destroyed and leakage soon follows. Yours truly, Ludwig Eid.

Cincinnati, O., March 13, 1897.

Washouts on the Cincinnati & Muskingum Valley R. R.

Sir: During March 3, 4 and 5 an unusually heavy rainfall occurred in Ohio, Indiana and Kentucky. Streams rose to a height exceeding long-established high-water marks, and much damage was done to railways. Among the heaviest losers was the Cincinnati & Muskingum Valley R. R. Forty miles of this road were more or less damaged. Traffic over the damaged portion was suspended on Friday, March 5, and was resumed on Thursday, March 11.

At bridge 157 the trestle approach and part of the high fill at the east end were washed.

Bridge 158 had its west abutment washed away, permitting the west span of the bridge to settle from under the track and float down stream. The east span was forced down stream until but one corner rested on the pier. The fill and trestle approach at the east end were damaged. The east span was pulled back into place and a framed bent trestle of nine bents was put under the west span in a little over two days.

When bridge 159 was reached by the repair gang, during the height of the flood, the west abutment had been washed out and the west span was found resting on a small bracket of broken masonry under the south chord. Timbers were laid across the T-wall and the span was suspended by ropes as shown. One of the workmen knocked the frail masonry support from under the bridge with a hand hammer and the bridge settled about 2 ft. Framed bents were placed under the span and the bridge was raised to place.

At bridge 163 the south wing, an old structure, and a large section of the high embankment approach were washed away. The T-wall here is an old limestone structure which during the past summer was encased with a 3-ft. thick sandstone wall resting on a concrete foundation 4 ft. wide and 3 ft. deep. This concrete was undermined its full width, arched itself for a span of 11 ft., and carried the 35 ft. of wall above it without showing a crack. There is 14 ft. of water in front of the abutment shown in the view.

In addition to these breaks in the line, several culverts, arches and bridges of minor importance were washed out, thousands of feet of fill were washed 6 ft. to 8 ft. deep, and innumerable slides in cuts and on fills either obstructed or undermined the track.

The work of reconstruction was under the personal supervision of Mr. C. M. Bennett, Superintendent, who was assisted by Messrs. A. L. Morgan and Ralph Howard, Assistant Engineers; Mr. H. F. Repass, Master Bridge Carpenter, and Messrs. Timothy and Edward Reilly, Supervisors. The work of getting the great quantity of earth, stone and bridge timber to the place where it was required for repairs was left to Mr. O. V. Porter, Master of Transportation, and was so executed by him that not a single hitch occurred in pushing the work. The work of permanent reconstruction of masonry has already been commenced by the masonry contractor for this division.

Yours truly, F. C. Neeb.

Lancaster, O., March 18, 1897.

Moving Freight Cars Around Sharp Curves.

Sir: In the construction of a street railway which is being put in here, the owners of the line wished to transfer freight cars from the steam railways, through the city. This would necessitate running over some very sharp curves (55 ft. radius). In writing for information on this line I found that several street railway lines had operated steam railway freight cars around curves of 90 ft. radius, but this seemed to be the minimum. Not being satisfied from the information I had gained that a freight car would not pass around a curve of shorter radius, and the matter being of enough moment to us, we concluded to make a test.

As a great deal of interest was manifested by all street railway people with whom I have talked or corresponded, and the matter being one of considerable importance in street railway construction, I send you the report of the test for publication.

The test was made at the yards of the Calumet Street Railway, Chicago, Ill.; 60-lb. T-rails were used, bent and put in place by the Paige Iron Works, Chicago; the radius was 55 ft., and both rails were guarded.

The first car run over the curve was car No. 305, Perry Mfg. Co., Indiana, built by the Terre Haute Car Co.; capacity, 50,000 lbs.; weight, 32,000 lbs.; truck centers, 30,15 ft. apart; length of car over all, 40½ ft.; width, 9¼ ft.; truck wheel base, 5 ft.; the corner overhang with car all on curve, 40 ins.; center overhang, 5 ft.

The only difficulty encountered was with the brakes. We found it would be necessary to remove the brake rods as they bound the brake beams against the wheels. After removing the brake rods, this 40½-ft. car could be operated with ease over the curve of 55-ft. radius.

We then put two cars of the Atchison, Topeka & Santa Fe Ry. around the curve. Length of cars over all, 37.70 ft.; width, 9¼ ft.; truck centers, 26.80 ft.; truck wheel base, 5 ft.; capacity, 44,000 lbs.; weight, 26,800. The corner overhang with car all on curve, 45 ins.; center overhang, 50 ins.

The plate bearings of these cars were the shortest usually encountered, being 12½ ins. for the upper and 3½ ins. lower. We found it necessary with all cars to remove the brake rods. A 3-ft. draw-bar was used, but a 30-in. draw-bar would have served the purpose better.

These experiments were made first with both rails guarded and afterwards the outer rail guard was re-

VIEW LOOKING WEST, SHOWING EAST SPAN BEING HAULED BACK ONTO PIER.

VIEW LOOKING EAST FROM TRESTLE APPROACH.

BRIDGE 158, CINCINNATI & MUSKINGUM VALLEY R.R., AFTER FLOOD OF MARCH 5.

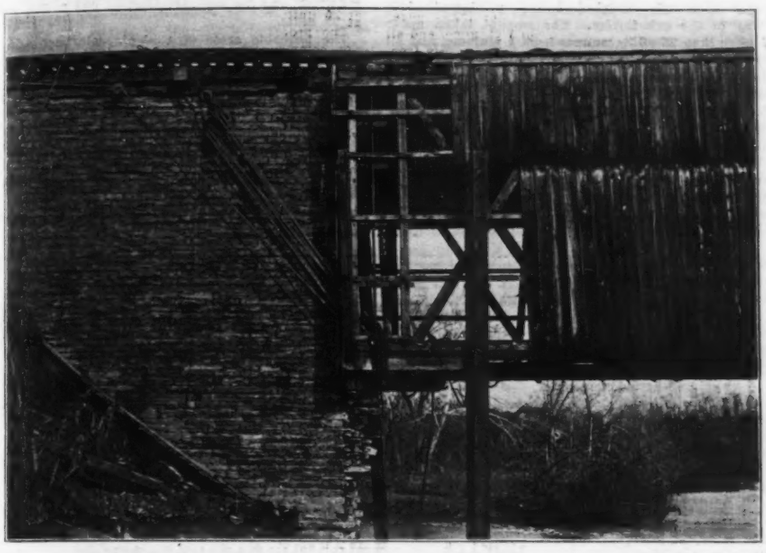
moved. The throat or flangeway betwen rail and guard was 2½ ins.

As a result of the above test I am confident that a steam railway freight car can be operated over curves of 50 ft. radius by removing the brake rods from the car.

Respectfully, Chester T. Dike,
Ch. Engr., M. C. & C. L. E. Ry.

Mason City, Ia., Feb. 22, 1897.

(From a table of sharp curves in the new book on "Railway Track and Track Work," by Mr. E. E. Russell Tratman, we find that curves of 50 ft. radius are in operation at the Center St. freight station, New York, and in the yards of the Pittsburg, Cincinnati, Chicago & St. Louis Ry., at Cincinnati, O., the latter extending 90°.—Ed.)



BRIDGE 159, CINCINNATI & MUSKINGUM VALLEY R.R.; WEST ABUTMENT WASHED OUT AND SPAN SUSPENDED BY ROPES.

Errors in Boiler Tests.

Sir: On reading the article in your last issue on "The Efficiency of Steam Boilers," the exaggerated reports of the water actually evaporated per pound of combustible has called my attention to another error which frequently enters the report of a trial; that is the percentage of moisture in the steam.

On examining reports of some of the trials at which steam of over 1%. See "Trans. Am. Soc. M. E.," Vol. VI., p. 293.

If the scales had been tested to 1-10-lb., the result can be correct only to about 1%. When a figure less than this is obtained it should be added to 1% and attention called to it in the report.

Usually 2% is as close as is determined with the barrel calorimeter, and a report of a trial, at which such an instrument was used, giving an entrainment of 2% may be considered as being dry steam or that it possibly contained 4% of moisture.

Edwin S. Boyer.
1405 Filbert St., Philadelphia, Pa., March 20, 1897.

(Our correspondent's criticism of the barrel calorimeter is quite correct, but its liability to error and its inferiority to the throttling calorimeter are so well known that we thought it was no longer in use. If there is any reason why anyone should continue to use the barrel calorimeter for boiler testing, we have never heard it.—Ed.)

Is There an Apprenticeship "System?"

Sir: I have read your editorial of March 4 on "The Improvement of the Apprenticeship System," etc., with much interest, but I think the real "defect in the working of the apprenticeship system of to-day" is the fact that apprenticeship as a system is dead, and that something better has taken, or at least is taking its place. In the days when apprenticeship was systematized by the old trades' guilds, and while that system was followed, an apprentice was indentured to work for a specified number of years under instructions (?) and without pay.

Now, although I do not think that 116 firms is a sufficiently large number from which to obtain data for generalization of mechanical practice, yet to use the figures you have tabulated, it appears that but 38% of these employers require a bond or retain even a portion of the boy's pay. Your summary of the requirements for successful apprenticeship is very good, but the trouble with its practical application is that your fourth requirement—"a diversified and carefully regulated course of shop training"—and your fifth requirement—"A course of special and general education to supplement the shop training"—can not be supplied in the shops of to-day. The "means that the practical exigencies of business will allow" are to-day totally inadequate, "the method of absorption" even with "diversity of labor" is a slow and unreliable educational process, and employers have evidently found that the time of their skilled mechanics can be more profitably used than in the instruction of apprentices.

The result is that the apprenticeship system has died out with the conditions that were favorable to it, and the capitalization of labor has introduced new conditions which require that almost all of the education of a mechanic shall be obtained outside of the shops. The manual training school which has been incorporated in the public educational system of most large cities, supplemented by the trades school, admirably fulfils the requirements specified above. A partial or complete course of study in the manual training school will give the broad general education of mind and body, and the trades school can add the specialized technical instruction necessary to make the expert artisan for a particular branch of mechanical work. To quote the words of Mr. William Sellers, from an address delivered before The Engineers' Club of Philadelphia, in January, 1890, "the master of an art or trade, as formerly understood, has no place in our present system," * * * "but let it once be understood and acepted that personal skill and deftness, coupled with the intelligence necessary for his (the student's) scholastic training, are all that is needful to enable him to master promptly the art of operating any machine, and regret for the departed system of apprenticeship will cease; for it will at once be evident that such training could be readily engrafted upon our public school system, and its graduates be thereby fitted for engaging profitably in their life work."

That this possibility has been since fulfilled will be evident to all who examine the results obtained by the manual training and trades schools of to-day, where the youth is trained by men who are not only experts but teachers, who are not obliged to do other work at the same time. Employers would do well, therefore, to apply their efforts to the improvement and multiplication of such schools, instead of wasting energy in trying to fit the old system of apprenticeship to the new methods of shop practice. Yours for progress, L. F. Rondinella.

705 Chestnut St., Philadelphia, Pa., Mar. 15, 1897.

THE ENGINEERS' CLUB, of New York, informally opened its new home, at 374 Fifth Ave., on March 17, moving from 10 West 28th St., the house it has occupied for the last eight years. The new club-house, formerly the home of Mrs. Coleman Drayton, is five stories high,

VIEW OF DRIFT ABOVE THE BRIDGE.

UNDERMINED CONCRETE FOUNDATION, 11 FT. SPAN WITHOUT A CRACK.

BRIDGE 163, CINCINNATI & MUSKINGUM VALLEY R.R., AFTER FLOOD OF MARCH 5.

I have been present, it was surprising that the engineer reported 1-10 of 1% moisture when he used the barrel calorimeter and his scales were tested to an accuracy of only ⅛-lb.

An error of 1-10-lb. in weighing the condensed steam, or ½-degree in temperature, will make an error in the final calculation for the percentage of moisture in the

and admirably adapted to its new use. Besides the reception rooms, cafe, dining room and two large reading rooms there is a special dinner room and 14 bed rooms are at the disposal of members. The Engineers' Club was organized in 1888 with about 50 members; it has since increased to 650 members, and the new club-house was a necessity.

THE CALORIFIC VALUE OF CERTAIN COALS AS DETERMINED BY THE MAHLER CALORIMETER.

By N. W. Lord[1] and F. Haas.[2]

This paper gives the results of experiments conducted in the metallurgical laboratory of the Ohio State University with the objects of determining: First, the calorific powers of a number of coals in general use in Ohio; and, second, how far ordinary analytical methods could be used as a basis for computing these values.

The Mahler calorimeter was purchased from L. Golaz in Paris, and is practically identical with the one described and figured by Mahler in his monograph "Contribution a l'Etude des Combustibles," from the "Bulletin of the Societe d'Encouragement pour l'Industrie National." A figure and description is also given by William Kent in "The Mineral Industry" for 1892, page 97.

There were furnished with the instrument three thermometers covering a range of from 7.5° C. to 31° C., which were carefully calibrated by the method published by Prof. Holman in the "Technology Quarterly" of September, 1887. From the calibrations it was concluded that for the differences of temperature measured in the calorimetric determinations of the coals in question (2°.4 to 2°.8 C) the readings could be relied upon to within 0°.005 C., which would correspond to about 14 units.

The unit of all the heat measurements in this paper is the quantity of heat required to raise 1 gramme of water 1° C. at laboratory temperature (15° to 25° C.). The heating powers can be converted into their equivalents in British thermal units by multiplying by nine-fifths.

The water-equivalent of the calorimeter was determined by adding to the calorimeter containing the bomb in position, and supplied with 2,200 grammes of water, weighed amounts of warmer water of accurtely known temperature, and determining the temperature-differences produced. The value 465 was adopted as being the most reliable.

The amount of water used in the calorimeter for the determination of the heating-powers was 2,400 grammes. This, added to the water-equivalent of the instrument, gives 2,865 as the total water-equivalent used in the calculation.

In all cases the samples of coal were prepared as for analysis by breaking up, mixing and quartering large amounts of the coal and finally putting the last portions through a fine sieve (at least 50-mesh). They were kept in tightly corked bottles until used. The objection noted by Mahler to the use of finely pulverized sample, as giving loss from coal blown away by the oxygen entering the bomb, was overcome by the method given by Hempel ("Gas-Analysis," p. 355). The pulverized coal was compressed under a screw-press by a steel piston in a hole bored in a block of cast-iron, forming a little briquette which was used in the combustion. No trouble whatever was experienced in getting perfectly coherent cylinders from any of the coals tested. In fact these would stand quite rough handling without breaking. The briquette of coal was accurately weighed before putting it into the tray of the calorimeter. The amount taken never varied more than 25 milligrammes from 1 gramme, and all results were calculated to 1 gramme. It will be seen from this that all the determinations of heating-power given in this paper represent the coal in question as accurately as a chemical analysis could do it so far as sampling is concerned. This would certainly not have been the case if anything but finely powdered and carefully mixed samples had been made the basis of the work. The oxygen-pressure used in the bomb in our experiments was only 16 to 17 atmospheres. While this pressure is considerably lower than that used by Mahler, it has been conclusively shown by Hempel to be amply sufficient for complete combustion.

An analysis of the gas from the bomb after one experiment showed the entire absence of CO and the presence of over 64% of O. Berthelot gives 60% of oxygen as the amount in the residual gas necessary to insure complete combustion. The sulphur in the coal, even at this pressure, is completely burned to sulphuric acid, and can be determined in the liquid washed out of the bomb. This statement, which is made by Mahler, is supported by our determinations.

The method given by Mahler for the calculation of the results was followed exactly. The acid contents of the bomb were titrated with standard ammonia, using methyl-orange as an indicator, as this is not affected by the iron salts invariably present in the solution. The nitric acid found, multiplied by 230, gives the heat-units to be deducted as due to the oxidation of nitrogen. As the total acidity includes that due to the sulphuric acid, Mahler's method of computing all as nitric acid would apparently lead to incorrect results. He says the error introduced is negligible in the case of the very low-sulphur coals he worked with. In some of our coals, however, the sulphuric acid produced is largely in excess of the nitric acid. Berthelot gives the heat formation of dilute sulphuric acid, which for 1 gramme of sulphur would be 4,388. Assuming the heat developed by sulphur burned to SO_2 at 2,250 units, this would give for the excess in question 2,138 units per unit of sulphur. This shows that a deduction must be made for the sulphuric acid as well as for the nitric acid; a calculation of the difference resulting from calling all the acidity nitric acid and from making separate allowance for the sulphuric acid and the nitric acid showed that in the case of the highest-sulphur coal examined it would only be 26 units or less than 0.4% of the heating-power of the average coal. Considering the uncertainty as to the exact value of the heats of formation involved, it has not been deemed necessary to make the separate calculation for sulphuric acid, and the results are given as calculated by Mahler from the total acidity.

The weight of iron wire used as fuse was 71 milligrammes, and the heat-development due to this was taken at 25 units.

The probable error of a single calorimeter-determination computed from the mean result of a large number of samples was 0.3%.

The chemical analyses were made by the ordinary methods—combustion with oxygen in a glass tube containing copper oxide and lead chromate for the ultimate analyses, while the proximate analyses were made by the methods used for all the samples analyzed in this laboratory for the Ohio Geological Survey. In outline the treatment was as follows:

One gramme of the coal was dried at 100° to 105° C. for one hour in a crucible, the loss being called moisture.

Upper Freeport Coal, Ohio and Pennsylvania.

Sample Number.	Location of Mine.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur	Ash.	Moisture.	Volatile Combustible.	Fixed Carbon.	Calorimeter Result.	Calorific Power Calculated from Ultimate.	Per cent. Difference.	Calorific Power Calculated from "H."	Per cent. Difference.
21	East Palestine, O.	70.58	4.88	7.76	1.24	3.65	11.89	0.82	34.98	52.65	7109	7182	— .8	7105	0.0
22	" " "	73.23	5.15	8.82	1.47	1.79	9.56	1.65	37.45	51.32	7390	7352	— .3	7346	— .2
23	Waterford, O.	74.29	5.15	7.80	1.40	3.44	7.82	1.55	37.29	53.34	7459	7529	— .9	7398	+ .8
24	Yellow Creek, O.	73.15	4.98	7.41	1.40	3.89	9.17	1.23	36.72	50.88	7464	7398	+1.0	7285	+2.6
25	Steubenville, O.	74.73	5.26	8.06	1.44	2.86	7.66	1.47	39.23	51.54	7504	7567	— .8	7455	— .7
26	Cambridge, O.	70.61	5.19	10.33	1.44	3.01	9.42	2.43	37.79	50.36	7068	7116	— .6	7217	—1.8
30	Steubenville, O.	71.40	4.62	10.64	1.20	3.00	9.10	2.40	39.20	49.30	7113	6970	+2.0	7230	—1.6
31	Salineville, O.	72.62	5.13	9.92	1.23	3.00	8.10	2.80	36.30	52.80	7271	7276	— .1	7297	— .4
36	Palestine, O.	71.29	5.00	9.28	1.54	2.64	10.45	2.15	36.70	50.70	7277	7136	+2.0	7176	+1.4
37	New Galilee, Pa.	73.57	5.20	8.94	1.35	2.24	8.70	2.30	36.70	52.30	7267	7491	—1.8	7235	— .9
40	Palestine, O.	73.64	5.06	9.47	1.24	2.34	8.25	2.45	36.60	52.70	7344	7340	+ .1	7350	— .2
	Average	72.65	5.06	8.95	1.34	2.89	9.10	1.93	37.35	51.63	7293	7292			

$$100 \times \frac{\text{Average Colorimeter Result} - \text{Average Sulphur} \times 22.5}{100 - \text{Average (Ash + Sulphur + Moisture)}} = \text{"H"} = \frac{7293 - 65}{8008} = 8898$$

Pittsburgh Coal, Pennsylvania.

15	Carnegie, Allegheny Co., Pa.	77.20	5.26	8.51	1.68	1.42	5.93	1.45	36.42	56.20	7691	7717	— .3	7736	— .6
16	Turtle Creek, " "	76.56	5.22	7.60	1.67	1.60	7.95	1.06	34.38	56.59	7630	7719	—1.2	7574	+ .7
27	Carnegie, " "	76.57	5.13	8.82	1.64	1.78	6.06	1.67	37.79	55.06	7765	7614	+2.0	7724	+ .5
28	" "	78.50	5.19	8.08	1.44	2.54	9.25	1.06	37.67	52.00	7398	7436	— .5	7407	— .1
29	Creedmore, " "	74.45	5.27	8.02	1.60	1.80	8.86	1.09	38.91	51.14	7496	7528	— .4	7484	+ .2
34	N. Mansfield, " "	73.91	5.15	8.89	1.22	1.77	9.06	2.10	36.20	52.65	7354	7404	— .7	7380	— .4
38	Turtle Creek, " "	74.48	5.05	8.39	1.37	1.66	9.05	1.75	36.20	53.00	7304	7433	— .5	7421	— .4
	Average	75.24	5.18	8.24	1.51	1.79	8.02	1.37	36.80	53.81	7532	7550			

$$\text{"H"} = \frac{7532 - 40}{.8892} = 8435$$

Middle Kittanning (Darlington Coal), Pennsylvania

17	Hoytdale, Lawrence Co., Pa.	77.83	5.22	9.38	1.65	1.57	4.35	1.60	36.40	57.65	7785	7719	+ .9	7774	+ .1
18	Beaver Creek, " "	74.60	5.06	8.23	1.49	1.96	8.75	1.56	34.38	55.42	7360	7462	— 1.3	7390	— .4
19	Wampum, " "	77.93	5.17	7.96	1.45	2.35	4.95	0.75	38.55	55.77	7825	7787	+ .5	7747	+1.0
20	Near Wampum " "	76.81	5.22	8.52	1.62	1.18	6.65	0.70	36.80	55.65	7638	7663	— .3	7681	— .5
*32	Hoytdale, " "	72.78	4.98	10.57	1.34	1.66	8.70	2.70	35.10	53.50	7245	7173	+1.0	7311	— .9
*33	Wampum, " "	72.82	5.25	8.55	1.38	2.53	8.80	2.55	37.50	50.85	7304	7396	—1.2	7194	+1.5
35	Clinton, " "	73.57	5.14	10.14	1.24	1.86	8.05	2.55	35.60	53.80	7260	7320	— .8	7266	— .9
	Average	75.19	5.14	9.00	1.46	1.98	7.18	1.81	36.32	54.69	7494	7502			

* 32 and 33 are from the same mines as 17 and 19, but taken some years earlier.

$$\text{"H"} = \frac{7494 - 44}{8908} = 8868$$

Middle Kittanning (Hocking Valley Coal), Ohio.

Sample Number	Location of Mine.	Carbon	Hydrogen	Oxygen	Nitrogen	Sulphur	Ash.	Moisture.	Volatile Combustible.	Fixed Carbon.	Calorimeter Result.	Calorific Power Calculated from Ultimate.	Per cent. Difference.	Calorific Power Calculated from "H."	Per cent. Difference.
6	Hocking Lump	69.42	5.35	16.27	1.46	1.67	5.83	6.72	37.13	50.32	6882	6790	+1.3	6886	+ .7
7	" " 2d sample					1.63	10.10	6.45	36.60	46.85	6603			6620	+1.3
8	Run of Mine	66.50	5.16	15.57	1.43	1.67	9.67	6.66	34.14	49.54	6496	6520	— .4	6537	— .6
9	" " " 2d sample					1.50	10.53	6.84	35.15	47.95	6482			6503	— .3
10	" Lump, 3d sample	68.18	5.36	15.09	1.44	1.43	8.50	6.40	36.05	49.05	6610	6740	—1.9	6662	— .8
	Average					1.58	8.93	6.51	35.82	48.74	6612				
	Average 6-8-10	68.05	5.29	15.64	1.44	1.59	8.00	6.59	35.77	49.64	6663	6683			

$$\text{"H"} = \frac{6612 - 36}{.8256} = 7925$$

Thacker Coal, West Virginia.

11	Run of Mine	78.90	5.14	6.88	1.42	1.16	6.50	1.40	35.00	57.10	7768	7876	—1.3	7811	— .5
12	" " 2d lot					1.18	7.50	1.60	34.75	56.15	7726			7707	+ .4
13	Nut Coal					1.81	7.30	1.18	36.07	55.45	7711			7723	— .1
14	" " 2d lot	79.40	5.19	7.56	1.40	1.40	6.05	1.35	36.35	56.25	7867	7691	+ .4	7840	+ .3
	Average					1.39	6.84	1.38	35.54	56.34	7771			7770	
	Average 11-14	78.65	5.17	7.22	1.41	1.28	6.27	1.38	35.68	56.67	7817	7853			

$$\text{"H"} = \frac{7771 - 31}{9089} = 8861$$

Pocahontas Coal.

1	"Run of Mine"	83.75	4.22	9.36	.85	.57	7.25	.80	18.30	73.65	8062	8089	— .3	8049	+ .2
2	" "					.60	8.00	.75	17.05	73.60	7915			7942	— .3
3	" "	85.46	4.25	3.24	.85	.57	5.63	.68	18.62	75.12	8185	8266	— .6	8206	— .3
4	" "					.63	6.99	.61	17.92	74.48	8080			8083	— .0
5	" "	85.40	4.89	3.94	.85	.62	4.80	.85	18.60	75.75	8281	8258	+ .3	8256	+ .3
	Average					.60	6.65	.73	18.10	74.52	8106			8107	
	Average 1-3-5	84.87	4.29	3.51	.85	.59	5.89	.76	18.51	74.84	8176	8198			

$$\text{"H"} = \frac{8105 - 13}{.9202} = 8794$$

Mahoning Coal.

39	Salineville, O.	71.13	4.95	9.93	1.23	1.86	10.90	3.15	35.00	50.95	7082	7088	— .5		

[1] Abstract of a paper read at the Chicago meeting of the American Institute of Mining Engineers, February, 1897.

[2] Professor of Mining and Metallurgy, Ohio State University, Columbus, O.

[3] Assistant in Metallurgy, Ohio State University.

After drying, the same portion was heated 3½ minutes over a Bunsen burner, then 3½ minutes over a blast-lamp, and the loss was called volatile combustion. The crucible was tightly covered and not allowed to cool during the change from burner to blast-lamp.

The results of the work are given in the following tables, in which the coals of each seam are grouped together. In addition to the analytical and calorimetric data the following figures are tabulated:

1. The calorimetric power computed from Dulong's formula in this form:

Cal. Power = 8,080 C + 34,462 (H — ⅛ O) + 2,250 S.

C, H, O and S being the amounts of carbon, hydrogen, oxygen and sulphur in one unit of the coal.

2. The difference between this result and the bomb-determination, expressed in percentages.

3. The heating-power of each sample calculated from the average heating-power of the coal-seam to which it belongs. This average heating-power was obtained by deducting from the average of the results of the calorimeter on all the samples of the seam in question the heat due to the combustion of the average sulphur, and dividing the result by the fraction left after taking out the ash, sulphur and moisture in one gramme of the average coal. Calling this result "H," the calorimetric value of each sample was estimated from it by multiplying "H" by the fraction left after deducting from one the ash, moisture and sulphur of the particular sample and adding to the result

so obtained the heat due to the sulphur of the sample, calling the calorific power of sulphur 2,250.

4. The difference between the result so obtained and the calorimeter-determination, expressed in percentages.

On examining the table of results the following points appear:

In the first place, the remarkable coincidence between the heating-powers, as calculated from Dulong's formula, and the experimental determinations. In the case of the averages of the different seams we find practical identity between the heating-power as calculated from the formula based simply on the heat developed by the combustible elements, and the results of the calorimeter. This is so much at variance with the claims of many writers that, were it not the result of so many determinations, it might pass as a mere accident. The maximum difference between the heat calculated from the elementary analysis and the heat developed in the bomb is 2% of the total calculated heat, the minimum difference 0.1%. The possible error of an ultimate analysis may be placed at 0.5% on carbon and 0.2% on hydrogen, especially with coals as high in ash and sulphur as are many of the samples included in our tests. This would lead to an error of about 108 units, or nearly 1.4% on the calculated heat-value. While, of course, the probable error of the ultimate analysis is less than this, is seems certainly possible that the difference between the observed and calculated heat-values are within the limits of experiment.

Taking the difference in groups, we find as follows, including all the samples with ultimate analysis:

Difference.					No. of Samples.	Per Cent of Total No.
Between 0.0%	and 0.5%	inclusive.....			17	50
" .5	" 1.0	"	.....		7	21
" 1.0	" 1.5	"	.....		6	18
" 1.0	" 2.0	"	.....		4	11
					34	100

The order of distribution of differences is sufficiently near that of the "probability curve" to lead to the conclusion that they were determined by chance and not by a law, though there is a decided preponderance of negative errors, especially among those of small amount. The close agreement shown between these two sets of values certainly indicates that the heat-values of the coals in question, if calculated from the ultimate analysis, might be expected to lie within 2% of the calorimeter-value—a closer limit than is set by Mr. Kent in his review of the Mahler work on the French coals.

The ultimate analysis of coals is vastly more difficult to make than the calorimeter-determination; and therefore it is extremely important to know how far the ordinary proximate analysis so universally used in this country, and so rapidly made, can serve as a guide in rating the calorific powers of coals.

A relation between the fixed carbon and the calorimetric test was stated by Mr. Kent ("Heating-Value of Coal," Min. Ind., 1892, p. 97); but the results of our work do not appear to correspond to his figures. Taking the Pittsburg coal, we find the average calorific power of the samples observed to be 7,532. The average ash is 8.02, the average moisture 1.37. Calculating from this the calorific power of the coal free from ash and moisture, we find it to be 8,313. The average fixed carbon is 53.95, and this, calculated ash and moisture-free, gives 59.54. Interpolating from Kent's table, this would give 8,054 as the calorific power, a difference of 259 units, or 3.2%. The same calculation on the average Freeport coal shows a difference of 296 units, or nearly 4%.

The determination of fixed carbon is very uncertain, being much influenced by slight changes in method; therefore it is entirely possible that these differences are due to our method of analysis, giving low results as compared with that used by the chemists furnishing his figures. We therefore investigated the results attainable by assuming the fixed carbon proportional within moderate limits to the heating-power, assuming that our results on fixed carbon were uniformly attained by the same method. In justification of this, it may not be out of place to say that the analyses were conducted with the same apparatus and in the same way that has been in use for years in the department: Applying this test to the Pittsburg coal, we assumed that the ash and moisture-free coal, with 59.54% fixed carbon, had the observed calorific power of 8,313, and then we calculated the value of each coal from this average, assuming its calorific power proportional to the fixed carbon. The following are the results:

Sample number.	Calorific power observed.	Calculated from fixed carbon.	Difference. Units.	Per cent.
15	7,691	7,830	139	1.7
16	7,630	7,900	270	3.4
17	7,765	7,690	75	1.0
28	7,396	7,260	136	1.7
29	7,496	7,140	356	5.0
34	7,354	7,350	4	.0
38	7,394	7,540	146	1.8

Showing that our determinations of fixed carbon could not be used for estimating the calorific power within any satisfactory limit of accuracy.

Attempts to derive a general law for all the coals examined were abandoned, and the question was taken up how far the coal of a given deposit or seam can be regarded as of uniform quality, and its specific character determined. This has led to the interesting results given in the tables. Taking the coals of the same seam, we averaged the results of the calorimeter, and, reducing by the average ash and moisture, soon found that comparable results were obtained by regarding this value as a constant for the seam over the area examined. The sulphur, existing to a large extent as pyrites, acted as a disturbing element, and it was found better to eliminate it by calculating from the average observed calorific power the value of the coal, ash, moisture, and sulphur-free. We assumed the value so determined to be the calorific value of the coal-vein in question.

On comparing these results for the several kinds of coal examined, seam by seam, it would appear that the actual coal of a given seam, at least over considerable areas, may be regarded as essentially of uniform heating value.

For the Freeport coal the samples extend from New Galilee, Pa., to Cambridge, Ohio, a distance of perhaps 80 or 90 miles in a direct line. The samples were taken at different times and by different parties, yet, on the assumption that the average heating value of the upper Freeport coal, ash, moisture and sulphur-free, is 8,398 units, the individual samples in seven cases out of eleven give values within 1% of those found in the calorimeter, and in only one case differed by more than 2%. In the case of the Pittsburg coal, the correspondence is still closer. The heating power of the actual coal of this seam is 8,435; and taking the samples from several mines the results calculated from this value in no case differ from the observed figures by as much as 1%.

In the next summary, the Middle Kittanning, we give results from two widely-separated portions of what is considered the same seam. In these two fields there has been marked change in the quality.

The Darlington coal of Lawrence county, Pennsylvania, shows a heating power of 8,368, and the estimated value of the coals from various mines agrees with the average. The No. 6 or Big Vein coal of the Hocking Valley, Ohio, is the same seam, but widely changed in character. The heating value of this coal, as determined by five samples, is 7,925. This vein includes most of the coal mined in Perry and Hocking counties, Ohio. The number for this seam is determined from too few samples to be entitled to great weight; but each determination represents, as accurately as they could be sampled, a number of tons of coal.

The figures for the Thacker coal and Pocahontas coal are given in the tables. These samples were made at different times from large lots of the coal as supplied to the University for steam boilers, and represent the run of the respective coals.

The results of our tests seem to indicate the interesting conclusion that the character of the coal seam, as far as its fuel value is concerned, is a nearly constant quantity over considerable areas. The determination of the value for seams would be of great use, as the rapid proximate analysis, or, for that matter, merely the determination of ash and moisture, in low sulphur coals, would be sufficient to grade coals of the same vein. Of course, it is dangerous to argue from so few samples; but the proposition seems reasonable. At least, we hope that further work may confirm these conclusions.

Since the table was compiled the following tests have been made in the Department Laboratory, and show the application of the value "H" for estimating the heating values of the samples and also the comparison of the results so attained with those of the calorimeter.

Sample.	Ash, %.	Moisture, %.	Sulphur, %.	Calorific power. Observed.	Computed.
A.....	3.80	7.30	0.80	7,024	7,000
B.....	6.60	5.90	1.38	6,863	6,856
C.....	3.65	5.02	0.87	7,374	7,138

The samples of the above table are all Hocking coals, but were taken at different times and from different sources. The last column but one gives the heating power as determined by the calorimeter; the final column, the same value as calculated from "H." Sample C, which shows a considerable difference between the two, was a small sample of selected lump coal, free from slate, "bone," and pyrites, and therefore not comparable with averaged samples of the same seam.

RAPID METHODS IN INSTRUMENTAL DRAWING.*

Engineering drafting is largely mechanical work, and the instruments or tools which are used are, therefore, of primary importance. For their quality and accuracy the draftsman must depend largely upon the reputation of the firm who makes them, but for improvements in their design his own appreciation of the value of labor-saving machinery should lead him to invent or adopt new devices that will enable him to do his work with equal or greater accuracy and in less time than by former methods. Unfortunately, however, draftsmen as a class are very conservative workmen, and are slow to see the need or advantages of new and improved instruments or methods. An illustration of this may be found in the fact that while for many years it has been customary with the best machine shops to use the inch for the unit of linear measurement, their draftsmen have been satisfied to use the architect's scale, which, while it contains one set of graduations in full size inches, has all the divisions for reduced sizes with the foot as a unit. In using these scales, therefore, the machine draftsman either loses time by mentally changing his values from inches to feet-and-inches before plotting them on his paper, or else uses the foot unit to represent an inch, and the twelfths into which it is subdivided for plotting the fractions of an inch—with great possibility of error. In representing machinery "half size," since there are "no 6 inches to the foot" graduations on the architect's scale as generally made, he must either use the last of the above methods or else divide all sizes by two and plot them as full size inches, with both loss of time and likelihood of mistake. It was the inconvenience which his students found in using the architect's scale for half-size inch measurements, that led the writer to search for a proportional scale having the inch for a unit, and not finding a practical one, he devised the Scale of Proportional Inches.* This is arranged exactly like the architect's scale (of proportional feet), but its purpose is entirely different. Its units represent inches, and the one beyond the zero point is, therefore, subdivided into sixteenths (instead of twelfths) to represent fractions of an inch. The method of using it for plotting inches and fractions will be self-evident to all who are familiar with the architect's scale for plotting feet and inches, and on drawings where all sizes are expressed in inches it will be found a great time-saver.

For measuring angles of all sizes, as the civil engineer is obliged to do in plotting his surveys, an accurate protractor is necessary; but for convenience in construction, mechanical engineers and architects base polygonal forms on the equilateral triangle, the rectangle, the regular hexagon, and the regular octagon, and their draftsmen have usually plotted angles from right-angled triangles accurately made of sheet material, with the acute angles 45° × 45°, 30° × 60° and 22½° × 67½°. Those who have only the first two of these triangles can plot, with the aid of the T-square, all angles that are multiples of 15°, while those who have the third also, can plot all multiples of 7½°. As it requires very careful manipulation in combining two triangles against the T-square, to form such angles as 15° or 37½°, and as it is inconvenient to have many instruments on the drawing board or to change frequently from one to another, some few attempts have been made to devise a single instrument to take the place of the first two, or of all three of the triangles above named, but the results have generally been too clumsy or expensive to be practical. The writer has spent considerable thought on this problem and has invented several forms, of which the best two have been in public use for some time, under the names of the Double Triangle and the Tetrangle. These are both quadrilaterals of hard rubber or transparent celluloid, having one or more inside edges made accurately so as to be used in addition to the four outside edges.

The Double Triangle, illustrated in Fig. 1, is for plotting all multiples of 15°. Two of its outside edges are at right angles to each other, and form the angles of 30°,

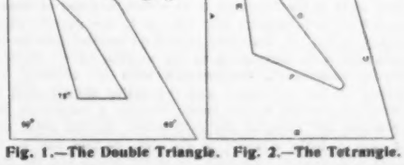


Fig. 1.—The Double Triangle. Fig. 2.—The Tetrangle.

45° and 60° with the two other outside edges, and the angles of 15° and 75° with the longest inside edge. During the past three years this instrument has been used by hundreds of students and professional draftsmen in place of the two triangles and has proved itself capable of doing their work in one-half or two-thirds the time.

The Tetrangle, shown in Fig. 2, is for plotting all angles that are multiples of 7½°. The sides of its right angle form the angles of 15°, 30°, 60° and 75° with the two remaining outside edges, and with one of the latter against the T-square blade the other makes the angle of 45° with it. The angles of 7½°, 22½°, 37½°, 52½°, 67½° and 82½° are formed by the three inside edges, as shown in the table of angles that is stamped on each instrument, as in the figure. The Tetrangle is especially convenient in architectural work and ornamental design.

Many draftsmen do not appreciate the time-saving value of cardboard scales and protractors. The former can be obtained with all kinds of graduations accurately printed upon good Bristol board, from machine-engraved copper plates, and they possess the advantages over boxwood scales, first, that they do not require to be flat on the paper throughout their entire length, and will allow other

*Condensed from a paper by Prof. L. F. Rondinella, Secretary of the Engineers' Club of Philadelphia.

*Sold by Keuffel & Esser, New York.

instruments to remain under them on the board, except just where measurements are being made; and second, that they change with the weather as the paper does, whereas the boxwood scale, especially in large work, if some measurements are made, for instance, on a rainy day, they will be smaller on a dry day, and it is then difficult to work accurately from them. Cardboard protractors can be obtained in semicircles or circles up

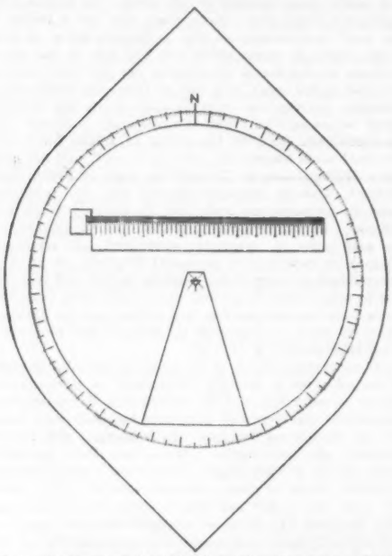


Fig. 3.—Instrument for Plotting Simultaneously Angles and Distances.

to 14 ins. in diameter, with accurate divisions to quarter degrees, which can be numbered to correspond with the system of readings taken in a survey. Used in connection with a cardboard scale as described below, such an inexpensive combination makes an instrument of greater scope and usefulness than the costly metal protractor with radial straight edge, to save the time of laying out courses before plotting measurements from each instrument station.

For use in radial measurement a cardboard scale should be selected with the desired proportional graduations on a perfectly straight edge, and may be prepared as follows: A knife-cut should be made from the blank edge about two-thirds across the scale at about one-quarter inch further in than the zero point, and the face of the cardboard should be scored from this cut to the end of the scale, forming a flap to be turned under and pasted to the back of the cardboard. When thus arranged a fine prick-point or needle can be pushed through the projecting part exactly at the zero of the scale, and may be driven through the drawing paper into the board, at the point where each instrument station is located, so that courses can then be measured directly from the edge of the scale.

The circular protractor should have a radius greater than most of the distances to be scaled, and the cardboard on which it is printed may be cut to the outside shape shown in Fig. 3. Numbers should be marked outside the graduations to correspond to the numbering on the surveying instrument, commencing with 0° opposite one corner of the cardboard, and the inside should then be cut out as shown in the figure, leaving a segmental flap of about 20° opposite the zero point. In the blunt end of this, a little triangle is cut out, so that one of its sides passes exactly through the center point, and the face of the cardboard is scored across the base of the flap, so that it can fold under the circle of the protractor. This

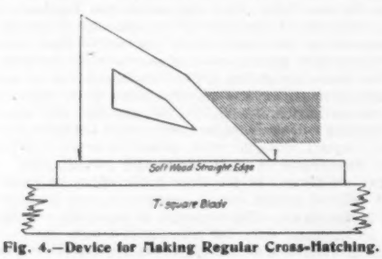


Fig. 4.—Device for Making Regular Cross-Hatching.

hinge may be strengthened by pasting a strip of tracing cloth or court plaster under it.

To use these two instruments in plotting topography notes, for instance, a line should be drawn northward lightly from the instrument station on the paper, and the protractor "set up" by making its center cover the instrument station with its zero point on the line. A weight is then put on the N. corner of the protractor, the opposite corner is lifted up so that the flap can be folded under, and a weight then put on it so as to hold the protractor firmly in place, and leave a clear open space around the instrument station on the paper. The zero of the scale is then set up at this point in the manner described above, and all the readings from that station can then be plotted as follows, greater speed being attained by an assistant reading off the notes while the draftsman plots them: First the bearing is read, and the scale is swung round till its straight edge covers that angle on the protractor; then the distance is read and marked as a pencil point at the corresponding division of the scale, which can then be turned out of the way. A small circle is now drawn around the point to indicate it more clearly; its topographical character, as stated in the notes, is marked on the paper by an abbreviation above it, and its elevation is marked below it, making the data for that point complete. All other readings from the same instrument station are then plotted in this way, ending with the reading to the next station; the protractor and scale are then moved, and set up again at the new point. If the proportional distance of any reading should fall over the cardboard of the protractor when the scale is at the proper angle, a straight line can be drawn lightly along its edge and the reading marked on it, so that when all other notes from that station have been plotted, the protractor can be removed, the scale swung back to the line, and the point marked with its data.

To make the cross-hatching on large section surfaces regular, without the aid of some spacing device, requires considerable time and experience, with strain upon the eyes; and though there are several excellent section-liners on the market, they are so expensive that but few draftsmen use them. A very good device, and one that has long been used in some drafting-rooms, can be made out of soft wood straight-edge, about ¼-in. thick (e. g., a penny ruler) and two pins, to be used with a trangle and against a T-square blade. One side of the triangle is placed against the upper edge of the soft wood on the paper, so that an adjacent side forms the angle desired for the hatchings, and the pins are driven into the edge so that the corners of the triangle can strike against them, the distance between the pins being equal to the side of the triangle plus the desired distance between the hatchings. To use this device, the lower edge of the soft wood is placed against the upper edge of the T-square blade, as shown in Fig. 4. With the angle against the left-hand pin, a line is drawn along its right-hand edge; the triangle is still held firm, and the straight-edge is slid to the left until stopped by the right-hand pin; the straight-edge is then held firm, and the triangle slid up to the left-hand pin; a second line is then drawn, and this process is repeated until the section surface is covered with equidistant lines. After a little practice, work can be done very rapidly with this device, and the eyes are not strained to judge the distance between the lines.

EXPORTS OF AMERICAN IRON.

"American Iron in Europe" is the subject of several reports from United States consuls, published in the Consular Reports for March, issued by the Department of State. Mr. Geo. F. Parker, consul at Birmingham, England, writes that for six months or more steel has been imported from the United States into Wales for use in the tin-plate trade, and that in January 1,600 tons of steel billets were shipped from Philadelphia for delivery in Birmingham. Editorial articles from the Birmingham "Post," of Jan. 21 and 22, are sent by the consul, which discuss the conditions which make the importation of American steel possible. Among these conditions are the facts that in England for some time prices of iron and steel have been steadily rising, under the influence of improved demand, and that in the United States they have been falling, due to the commercial depression. There is nothing new, says the "Post," in the importation of American pig iron, which can be produced now at prices with which English and Scotch smelters cannot pretend to compete. It says further:

If English steel manufacturers could see their way to cheapen production by the adoption of American plant and process, there would be little to apprehend in the future from American competition. For the moment, however, it must be admitted that in certain lines we are beaten by our American competitors; or, in other words, that the upward movement of prices has reached, if it has not passed, the limit of safety.

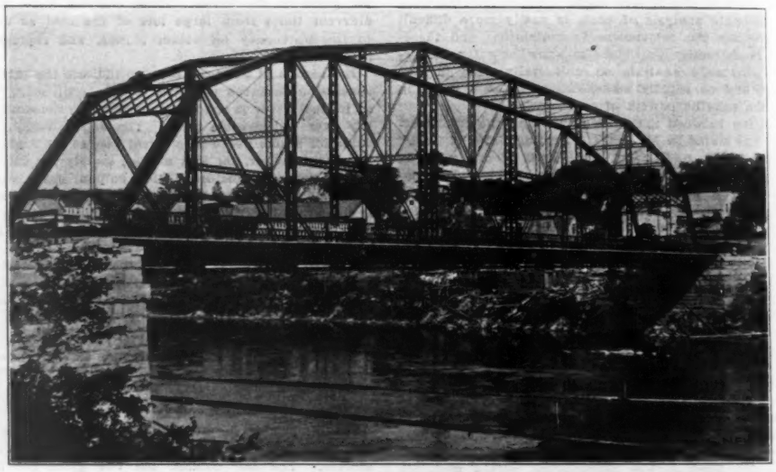
In its issue of Jan. 22, the "Post" continues the discussion at great length. Among other things it says:

The continued prosperity of the British iron trade would seem to show that in good times there is room in iron markets for American as well as English iron; but it would be a fatal mistake for English ironmasters to acquiesce in that state of things without making a determined effort to expel the intruder. That the American competition in this country will long survive the present trade depression in the United States we do not believe, but it is neither prudent nor dignified for British ironmasters to be dependent upon the tactics or opportunities of their trade competitors, and even in times like these it ought not to be possible for steel and iron producers in the United States to send their manufactures many thousands of miles to this country at prices which defy British competition.

The Germans are not at all alarmed at the prospect of importation of iron from the United States, according to the report of Mr. Perry Bartholow, Consul at Mayence. He says:

A German is not going to order too much. He is used to ordering small quantities at a time, just as he may need, from the factory or wholesale dealer, and it will be impossible to educate him up to our way of ordering a large stock at a time from America or anywhere else. The Germans say that if the Americans want to compete in Germany they will have to carry large stocks of goods on this side, to be ready for any demands made on them. This, they think, the Americans will never do; they argue that it will take too much capital and cost so much that the profits will not pay them, and that owing to this increase in cost and outlay of capital the American will not be able to undersell them. They claim that should the time ever come when the American can favorably compete with their blast furnaces and their steel trade, he (the American) would immediately, through formation of trusts and rings, keep up the prices, and that the government would have to come to the rescue of the German or home industries.

American pig iron has lately been introduced into the Trieste (Austrian) market, according to a report from Mr. J. G. Haggard, the British consul at that port, at prices with which British iron cannot compete. It has been chiefly brought in by the Austro-American steamers, subsidized by the Austrian government, which are mostly freighted with cotton; but some iron has also been brought in British bottoms. It is said that large stocks from the United States are being laid in by the great ship-building firms in Trieste.

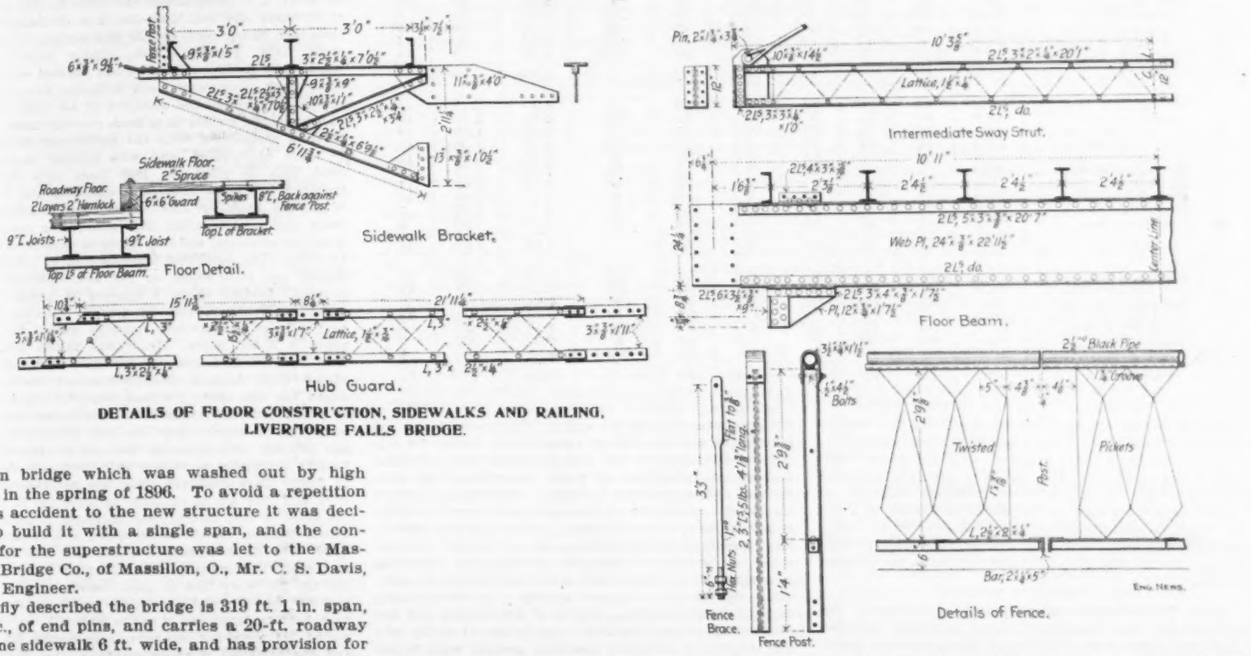


VIEW OF 319-FT. SPAN HIGHWAY BRIDGE, LIVERMORE FALLS, ME.

HIGHWAY BRIDGE OF 319 FEET SPAN, LIVERMORE FALLS, ME.

(With full-page engraving.)

An especially interesting example of American practice in the construction of long span, pin-connected, steel highway bridges is illustrated by the drawings on our inset sheet this week. This bridge crosses the Androscoggin River at Livermore Falls, Me., between the towns of Livermore and East Livermore, and replaces an old covered wooden bridge which was washed out by high water in the spring of 1896. To avoid a repetition of this accident to the new structure it was decided to build it with a single span, and the contract for the superstructure was let to the Massillon Bridge Co., of Massillon, O., Mr. C. S. Davis, Chief Engineer.



DETAILS OF FLOOR CONSTRUCTION, SIDEWALKS AND RAILING, LIVERMORE FALLS BRIDGE.

Briefly described the bridge is 319 ft. 1 in. span, c. to c., of end pins, and carries a 20-ft. roadway and one sidewalk 6 ft. wide, and has provision for a second walk to be added when it may be desired. The metal work was designed according to Cooper's Class B highway bridge specifications of 1890, with slight modifications, and the material used was soft steel for angles, channels and plates, medium steel for eye bars, pins and rollers, and iron for lateral rods and counters. The roadway floor is two layers of 2-in. hemlock plank and the sidewalk floor one layer of 2-in. spruce. All the principal details of members and connections for both trusses and floor system are shown by the drawings and need no further explanation. The superstructure complete cost $13,100, and it was constructed under the supervision of Mr. Chas. A. Mixer, M. Am. Soc. C. E., of Rumford Falls, Me.

ASPHALT FOR PAVING PURPOSES has been under investigation by a council's committee at Pittsburg, Pa. The committee was appointed to consider the relative merits of Trinidad and Bermudez asphalts, but as the testimony developed that there were other natural asphalts which equal Trinidad or Bermudez, it was then resolved to widen the scope of the investigation so as to cover all natural asphalts used for street paving. The committee recommends a guarantee of five years on all new streets paved with asphaltum and 10 years on all streets repaved with asphaltum. It also recommends that when proposals are advertised for repaving the kind of asphaltum determined upon shall be specifically stated in the advertisement, and proposals received only on the kind of pavement specified.

FOREIGN IRON AND STEEL STATISTICS are noted as follows: Germany's exports of iron, steel and hardware, for 1896, amounted to 1,518,626 tons, as compared with 1,527,852 tons in 1895. The total exports of machinery, etc., amounted to 181,227 tons in 1896, as compared with 158,788 tons in 1895, and the total official value of these exports was $110,000,000, as against $114,500,000 in the previous year. Belgium's output of Bessemer and open-hearth steel ingots amounted to 598,755 tons in 1896, a gain of 144,136 tons over the previous year; and the output of finished steel amounted to 408,756 tons, against 367,947 in 1895. The total output of pig iron in Belgium, in 1896, was 932,780 tons, a gain of 108,546 tons on 1895. Of this total 501,105 tons were Bessemer and basic, 364,640 tons forge and 66,945 tons foundry iron. Under the special tariff law between Germany and Russia, negotiated some years ago, Germany's export business has largely increased. In 1896, Germany's export of iron and steel to Russia amounted to 207,540 tons, exclusive of 34,940 tons of machinery. The gross value of these two items was over $11,000,000, and it practically represents an export formerly coming from England.

THE LAKE SUPERIOR ORE POOL was formally dissolved at a meeting of the Association of Ore Producers on March 23, owing to a failure of the different producers to agree upon prices for the current year. Last year the price of Norrie, the standard Gogebic ore, was $4 per ton, and that of Fayal, a standard Mesaba ore, was $3.55. This year some of the larger producers, since the making of the Rockefeller-Carnegie deal, have been anxious to depress the price to the lowest possible limit, and proposed to the pool to reduce Norrie to $2.65 and Fayal to $2.40. These prices, the smaller producers say, would close up all the smaller mines and might also prove a serious hardship to labor. They proposed to compromise on $2.85 or $2.90 for Norrie and $2.60 or $2.65 for Fayal, but the owners of the larger mines would not agree, and the pool was therefore dissolved. Wages have been reduced at some of the mines, but some of the larger interests, including the Rockefeller mines, say that they will not reduce wages no matter to what prices ore may fall. An official statement issued by the ore producers says:

> The failure of the ore men to get together is due entirely to the Rockefeller-Carnegie people, who have slowly absorbed all the large interests on the Mesaba range, and can therefore afford to be independent with an ultimate view of controlling the entire ore producing properties in the Lake Superior country.
>
> The dissolution of the pool makes it certain that low prices for ore will prevail during 1897, and that the cost of making pig iron will be lower than ever it was before.

A STEEL GRAIN ELEVATOR with a capacity of 3,000,000 bushels is to be built at Buffalo, N. Y., at the foot of Gansen St., by the Great Northern Ry. Co., and the contract has been awarded to Rieter & Conley, of Pittsburg, Pa. The grain will be stored in a series of enormous steel tanks, of circular shape, with spherical bottoms and a height of about 70 ft. These will be carried on heavy circular girders resting on steel columns. On top of the tanks will be located the cupola building containing the conveyor, machinery, platforms, distributing tanks, etc. The whole building will cover an area 120 × 400 ft., and the height from the ground to the top of the roof will be 160 ft. The grain will be handled by means of three large movable towers of structural steel, arranged with an elevator system for raising grain from barges into the storage tanks. Between 5,000 and 6,000 tons of plates and shapes will be used in the structure, and this material is now being manufactured, as the work is to be pushed to rapid completion.

SHINNECOCK BAY, near the extreme eastern end of Long Island, has again been connected with the Atlantic by a canal, excavated by the State of New York. This bay covers about 16 sq. miles and is separated from the ocean by a comparatively narrow beach of shifting sand. The inlet was always difficult to keep open, and about seven years ago a heavy southeast gale closed it completely and various local attempts to open it failed. The state then went to work to cut a canal across this beach, about 1,650 ft. wide and 15 ft. above high water mark at the highest point, with the result that a canal 90 ft. wide now contains about 3 ft. of water and is rapidly deepening. The chief purpose in making the canal is to improve the water of the bay, which was becoming stagnant, and to again admit fish to what was once a famous fishing ground.

RAILWAY CONSTRUCTION DURING 1897, ACCORDING to statistics published by the "Railway Age," is likely to be more active than during either 1895 or 1896. The figures show that there are 300 lines, aggregating 17,512 miles of railway, which are either under construction or are projected with some reasonable prospect of being placed under construction during the year. Referring to these figures the "Railway Age" says:

> So many of the lines run through two or more states that it is difficult to give the mileage accurately by states, and we have therefore grouped it by sections of the country, as follows:.

	No. Lines.	Miles.
New England states	14	301.00
Middle states	47	946.35
South Atlantic states	60	3,322.20
Gulf and Mississippi Valley states	32	2,347.00
Central Northern states	52	2,849.50
Northwestern states	13	1,112.50
Southwestern states	61	5,486.76
Pacific states	21	1,136.49
Total in 46 states and territories	300	17,511.74

> The states showing the greatest projected mileage are: Indian and Oklahoma territories, jointly, 1,917 miles; Texas, 1,565 miles; Missouri, 877 miles; Indiana, 807 miles; Georgia, 805 miles, Illinois, 706 miles; Louisiana, 665 miles; West Virginia, 659 miles; Alabama, 633 miles; Pennsylvania, 588 miles; Virginia, 581 miles; Wisconsin, 501 miles. The remaining states show less than 500 miles each.
>
> In studying these figures it has always to be borne in mind that they are at the best only approximations based on an estimate of conditions which are sure to change in many cases before the year ends and prevent active work. Probably not more than from 15% to 20% of this projected mileage can be expected to be pushed to completion during the year under the most favorable circumstances.

THE LAKE ERIE AND OHIO SHIP-CANAL COMMISSION will get the $10,000 appropriated by the Pittsburg councils last year, for the purpose of the commission. At least, Judge White has handed in an opinion to that effect and awarded a mandamus against City Controller H. I. Gourley, requiring him to pay this amount. The Judge decides that the feasibility of a ship-canal was a proper subject for councils to enquire into, and that an appropriation made by them for this purpose must therefore be paid.

WIDER SPANS FOR OHIO AND MONONGAHELA River bridges are being considered by the U. S. Engineers, and the Secretary of War authorizes a board to hear testimony in reference to these alterations, at Pittsburg. The board, assembled on March 17, included Major H. E. Heuer, Major James L. Gregory, Major R. L. Hoxie and Lieut. M. M. Partrick, all of the Engineer Corps, U. S. A. The special bridges referred to are not named, but a statement was presented showing that the loss to commerce by collisions with the 15 bridges over the Ohio, between Beaver bridge and Cairo bridge inclusive, was

WEATHER TABLE FOR FEBRUARY, 1897. (Furnished to Engineering News by the Department of Agriculture.

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—rain or melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	18.3	43	-15	58	8.0	32	S	1.53	.54	11
	Portland, Me.	26.0	45	6	39	7.6	38	SE	2.60	.75	7
	New York City	32.6	53	17	36	14.0	60	E	2.72	1.00	9
	Pittsburg, Pa.	35.0	61	8	53	6.9	29	W	4.30	1.46	12
	Chicago, Ill.	28.6	44	— 6	50	16.6	51	E	2.22	.45	10
	Omaha, Neb.	27.2	59	— 11	70	7.8	24	NW	0.63	.54	6
	St. Paul, Minn.	18.6	36	— 22	58	7.3	29	SE	1.05	.29	12
	Duluth, Minn.	18.6	34	— 20	54	9.9	45	NW	2.21	.40	14
	Bismarck, N. Dak.	6.6	33	— 25	58	8.2	48	NW	1.32	.78	14
	Average	23.5	45	— 8	53	9.6	40		2.06	.69	11
Southern Cities.	Washington, D. C.	36.6	63	12	51	7.5	36	N	6.47	2.19	14
	Louisville, Ky.	38.6	67	10	57	8.9	30	SW	4.04	1.51	13
	St. Louis, Mo.	36.8	71	8	63	10.6	31	S	2.67	1.36	11
	Savannah, Ga.	56 6	81	32	49	9.2	27	SE	8.85	2.66	13
	Kansas City, Mo.	32.9	59	4	55	8.0	26	N	1.65	.72	10
	Jacksonville, Fla.	60.0	84	34	50	8.5	42	SE	7.10	2.37	13
	Chattanooga, Tenn.	47.0	76	19	57	8.4	37	W	5.52	2.06	11
	New Orleans, La.	58.0	81	37	44	9.8	33	S	4.82	1.64	10
	Memphis, Tenn.	46.5	76	20	56	10.6	43	E	5.17	1 57	7
	Palestine, Tex.	55.2	82	26	56	8.5	24	S	0 29	.20	4
	Average	46 8	74	20	54	9.0	33		4 66	1.63	11
Western Cities.	Helena, Mont.	24.8	44	4	40	6.9	48	SW	1.49	.32	11
	Port Angeles, Wash.	40.3	55	30	25	5.4	30	SW	2.19	.68	16
	San Francisco, Cal.	50.7	66	38	28	9.4	37	W	4.41	1.23	17
	Salt Lake City, Utah.	30.9	47	12	35	5.6	32	S	3.81	1.01	17
	Santa Fe, N. Mex.	30.7	58	13	45	7.6	40	SW	1.10	.33	9
	Denver, Colo.	31.2	65	8	57	7.5	46	W	0.82	.22	9
	Yuma, Ariz.	57.4	83	37	46	7.5	35	NW	0.06	.06	1
	Average	38.0	60	20	39	7.1	38		1.98	.55	11

$715,333 to Dec. 31, 1896. The Steubenville and Bellaire bridges are especially condemned by the coal-carriers as having inadequate channel spans. It is not known what action the board will take, but it is generally supposed that they will recommend the alterations proposed. It would cost the bridge owners about $1,000,000 to make the changes contemplated. Representatives of the companies which own the various bridges vigorously protest, on the ground that the government approved the original plans.

TWO UNARMORED COMPOSITE GUNBOATS, the "Wheeling" and "Marietta," were launched together from the yards of the Union Iron Works, of San Francisco, Cal., on Mar. 12. These boats are each 174 ft. long on load water line, 34 ft. beam, 12 ft. mean draft, with 1,000 tons displacement. They have twin screw vertical triple expansion engines of 800 I. HP., designed to impart a speed of 12 knots per hour. The main battery includes six 4-in. rapid-fire guns, with four 6-pdr. and two 1-pdr. rapid-fire guns in the secondary battery. The crew will be made up of ten officers, 125 sailors and a marine guard of 10 men. These boats have a very small amount of canvas. The two boats were launched simultaneously from parallel ways, and when they reached the water they crashed into each other, bending some of the plates above the water line. The gunboats "Helena" and "Wilmington," lately launched at Newport News, will shortly have their trial trip in Long Island Sound. The contract speed is 12 knots, but 14 knots is expected by the builders, the Newport News Shipbuilding Company.

THE NEW TIMBER DRY DOCK, at the Brooklyn Navy Yard, has been tested by the docking of the monitor "Puritan." This vessel, of 6,060 tons displacement, was hauled into the dock on March 17, floated all around the dock, and then the caisson gate was put in place and the dock pumped out. The naval Board of Survey expressed itself much pleased with this first test of the new dock. When some repairs are made on the "Puritan" she will be replaced by one of the large battle ships.

BOOK REVIEWS.

THE DESIGNING AND CONSTRUCTION OF STORAGE RESERVOIRS.—By Arthur Jacobs, B. A., late Executive Engineer for Irrigation. H. M. Bombay Service. Second American Edition, revised and extended by E. Sherman Gould, M. Am. Soc. C. E. Consulting Engineer for Water-Works. Van Nostrand Science Series No. 6; 12mo.; 138 pp.; 50 cts.

In the present edition of this useful treatise on storage reservoirs, the author has corrected a few misprints appearing in the original edition and has made important additions and changes in the closing chapter of "Additional Remarks" by the American editor, as gained from practical experience in constructions of this character.

ELECTRIC POWER TRANSMISSION.—A practical treatise for practical men. By Louis Bell, Ph. D., M. Am. Inst. E. E. New York: W. J. Johnston Co. 8vo.; cloth; pp. 486; illustrated; $2.50.

The aim of the author of this work is to set forth in the simplest manner possible the present practice in electrical power transmission. It is intended rather for the business man than for the student, though the detail and facts given are not without value to the latter. To this end the first chapters deal with the elementary principles and general conditions of power transmission by continuous and alternating currents. Succeeding chapters take up the adaptation of the particular current available to special uses, by commutators, motor dynamos and rotary transformers; discussions of the prime movers, steam or hydraulic; hydraulic development, including measurements of power and means of making it available; organization of power stations; the transmitting line and its construction, centers of distribution and the commercial problem involved. The treatment of the several chapters is eminently practical, and the work is full of useful hints to those proposing electrical power transmission or a change from other forms of power.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA.—By Charles Proteus Steinmetz, with the assistance of Ernst J. Berg. New York: The W. J. Johnston Co. Cloth; 8vo.; pp. 431; $2.50.

Mr. Steinmetz is a well-known writer on electrical subjects. He was the author of a paper on the application of complex imaginary quantities to electrical engineering, read before the International Electrical Congress, held in Chicago in 1893, and the present volume well sustains his reputation as an expert in the handling of both real and imaginary mathematical quantities. In his preface the author states that the book is intended as an exposition of the methods he has found useful in the theoretical investigation and calculation of the manifold phenomena taking place in alternating current circuits, and of their application to alternating current apparatus. The book is not intended as a first instruction for a beginner, but presupposes some knowledge of electrical engineering. The author has endeavored to make it, however, as elementary as possible, and has, therefore, used only common algebra and trigonometry, practically excluding calculus. A part of the book is original investigation published now for the first time. The following titles of some of the chapter headings will give an idea of the scope of the work: Instantaneous and integral values. Law of electro-magnetic induction. Graphic representation. Symbolic method. Admittance, conductance, susceptance. Circuits containing resistance, inductance and capacity. Resistance and reactance of transmission lines. Foucault or Eddy currents. The alternating current transformer. Induction motor. Synchronous motor. Distortion of wave-shape and its causes.

The style of the author is severely concise. He treats his readers as if they were already well acquainted with the general principles of alternating currents and with the whole terminology of electrical science, including words of recent coinage, and wastes no words in elementary explanations. To the educated electrical engineer the book will no doubt be a welcome addition to his library, but as the author states, it is not intended for beginners.

COMMERCE AND INDUSTRIES OF JAPAN.—A Report of Investigations conducted by Robert P. Porter, under the direction of the National Association of Manufacturers of the United States of America. Philadelphia, 1896. 8vo.; pp. 165.

Under instructions from the Association Mr. Porter went to Japan in March, 1896, and spent some months in personally investigating all important industries and in gathering a vast amount of valuable statistical information. The results of this work are given in this book, and it includes data of the greatest importance to the commercial world and to students of industrial development. Those industries where competition with the United States is most keenly felt are most fully dealt with and the minute details of the industries themselves are given. One of the most startling statements made in the introductory chapter, and a statement in itself partly explaining the low wages which prevail in Japan, is that relating to the density of population. Mr. Porter says that the 45,000,000 Japanese live upon an area of 148,000 sq. miles, a territory about equivalent to that of the State of Montana and less than the area of California. And even then 85 per cent. of this land surface is occupied by rocky hills, volcanic cones, pebbly rivers, mountain lakes, ashy fields and large areas covered with pine and other trees. Commercial and industrial development now completely absorbs the attention of all classes in Japan, and wonderful strides have been recently made. Railway building commenced with the government in 1872, with 18 miles constructed, and with private corporations in 1883, with 38 miles. In 1895 there were built and in operation 593 miles of government lines and 1,650 miles of private lines, or 2,243 miles in all. Seven government lines, aggregating 925 miles, are projected and under construction, and it is hoped to have them completed by 1903. The estimated average cost of construction is $74,847 per mile silver, or say about $38,000 per mile in gold. Besides these, a number of private lines are under construction, and the present estimate of aggregate mileage of Japanese railways within the next ten years is 20,000 miles. Mr. Porter thinks that there is here an important field for American endeavor, in supplying rails, bridges, locomotives and track material. Japan has also taken practical steps for the development of a merchant marine, with navigation and ship-building laws framed largely upon the bills introduced ten years ago into our own Congress, but not yet passed, and extending protection to both ship-builders and ship-owners. In Japan these measures came into operation on Oct. 1, 1896, and they are to continue in force for 15 years. As yet there is only one private dockyard in Japan of sufficient capacity for the construction of a steamer of over 1,000 tons displacement; but the new law is expected to develop this industry, as it provides a subsidy of $12 per ton for every iron or steel vessel, ranging from 700 to 1,000 tons, and $20 per ton for every vessel over 1,000 tons, built in Japan and of native material. In 1895 Japan owned 517 merchant steamers, aggregating 321,522 tons, and the principal shipping company, the National Mail Steamship Co., alone possessed a fleet of 57 ocean-going steamers, aggregating 101,342 tons.

Mr. Porter takes up in detail the foreign trade of Japan, prospective Chinese competition, the cotton, silk, paper, rug and match making, lacquer, porcelain, glass and other industries of Japan. In this connection he goes minutely into the methods of manufacture, character of the product, wages paid and cost of living. In the latter connection he states that the simple difference between the $2.75 per day in American money which he paid at his hotel and the 40 cts. which a highly educated Japanese friend paid at the native department of the same hotel, was the gage of the amount of energy expended in supplying the daily wants of one and the daily necessities of the other. It also represents the difference between Asiatic and American labor, and explains why the workman of one nationality can get along very well on 27½ cts. per day in gold when the other demands $1.50 in good, sound money simply to supply his daily wants. It may be said, however, from the graphic picture of the lower Japanese life presented by Mr. Porter, that what these people regard as necessities, and seem perforce to be content with, would be looked upon as the deepest depths of poverty by any American or European people. Even in Japan it is evidently hard work to sustain life on wages that in some cases are as low as 2½ cts. gold for 10 hours' hard work.

In conclusion Mr. Porter says that while Japan has recently made marvellous strides in manufacturing, the real industrial importance of the nation is liable to misconception and some exaggeration. That Japan will become a great industrial nation is not to be questioned, but its greatest industries to-day are where those of the United States and Great Britain were a century ago. They are still largely household industries, using hand labor only; and the transition period to machinery is likely to be prolonged by the insufficiency of operatives capable of building, working and repairing modern labor-saving machinery. With the change to come, wages and the cost of living will advance; and, in fact, the necessaries of life have already advanced 62 per cent. in price between 1873 and 1894. But the present industrial development in Japan opens a promising market for American wood and metal-working machinery and tools, manufacturing supplies and materials; and the rapid extension of the Japanese railway system presents another market for rails and track supplies. The domestic wants of the Japanese are so extremely simple and limited and the earning power of the people is so small, that, so far as the ordinary necessaries or luxuries of life are concerned, Japan offers little promise of a possible market.